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The British Journal of Surgery

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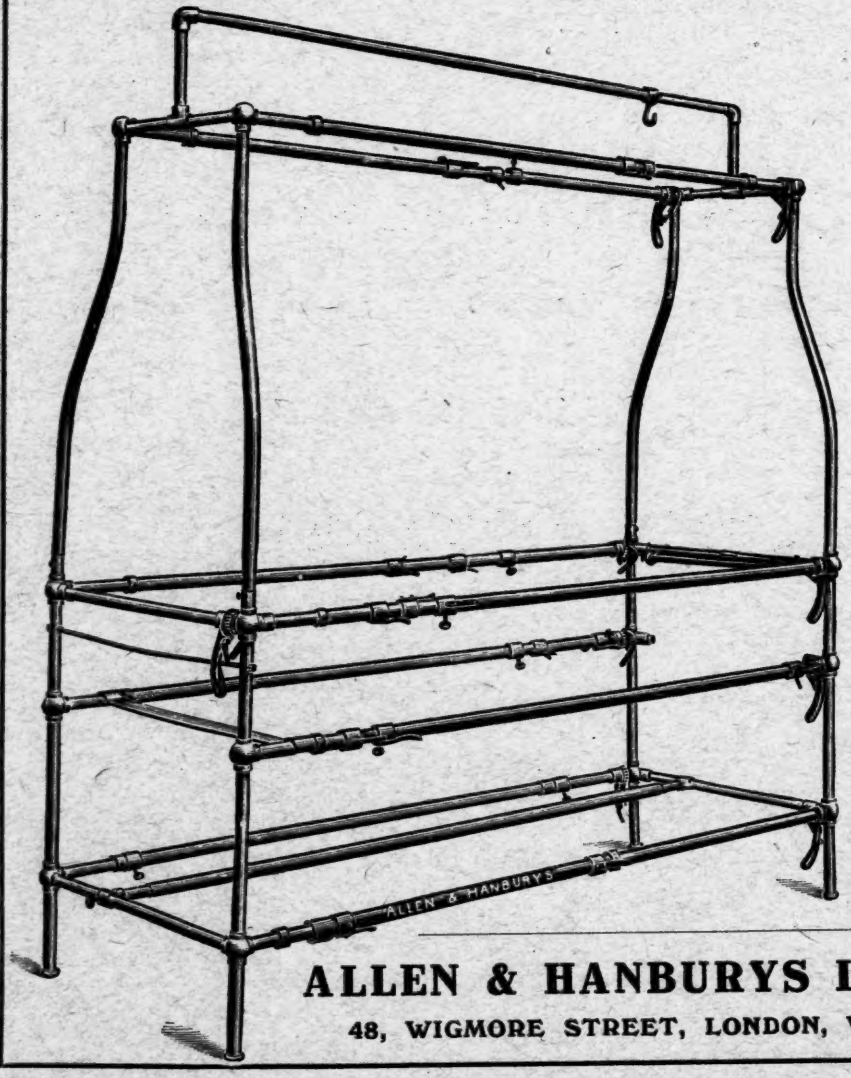

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SIR WILLIAM FERGUSSON.

1808–1877.

Born at Preston Pans on March 20, 1808, the son of James Fergusson, of Lochmaben, Dumfriesshire, William Fergusson was educated at the High School, Edinburgh, and after spending two years in a lawyer's office, he began to study medicine at Edinburgh at the age of seventeen. He soon attracted the notice of Robert Knox—then at the height of his fame as a teacher of anatomy—by his mechanical ingenuity and the excellence of his dissections. Knox appointed him a chief assistant in the dissecting rooms at the Old Surgeons' Hall, where four hundred students attended daily. In this position Fergusson showed such a decided bent for surgery, that Knox commissioned him to give a special course on surgical anatomy—then a new feature in anatomical teaching. In 1833 this course had proved so great a success that Dr. John Reid joined Knox and Fergusson, paying £250 for the privilege, and receiving a third share of the proceeds. In 1828 Fergusson became a Licentiate and in 1829 a Fellow of the Royal College of Surgeons of Edinburgh. In 1831 he was appointed Surgeon to the Edinburgh Royal Dispensary, and in 1836 he was elected Surgeon to the Royal Infirmary. By this time he was sharing with Syme the chief surgical practice in Scotland.

Rendered independent by his marriage in 1833 with Helen Ranken, daughter and heiress of William Ranken, of Spittlehaugh, Peebles-shire, he came to London in 1840 on his appointment as Professor of Surgery at King's College and Surgeon to King's College Hospital. He was admitted a Member of the Royal College of Surgeons of England after examination in 1840, and was elected an Honorary Fellow of the College in 1844, living at first at 8, Dover Street, Piccadilly, and afterwards at 16, George Street, Hanover Square. He quickly attained a large surgical practice, which became still larger after the death of Robert Liston in 1847. He was appointed Surgeon in Ordinary to Prince Consort in 1849, Surgeon Extraordinary to the Queen in 1855, and Serjeant Surgeon in 1867, having received a baronetcy in January, 1866. In 1861 he was elected—not without strenuous opposition—a Member of the Council of the Royal College of Surgeons of England; but he was soon appreciated at his proper worth, for he was elected a Member of the Court of Examiners in 1867, and after serving various minor offices, was chosen President in 1870. He died of Bright's disease on Jan. 10, 1877, and was buried at West Linton, near Edinburgh, leaving two sons, Lady Fergusson having predeceased him.

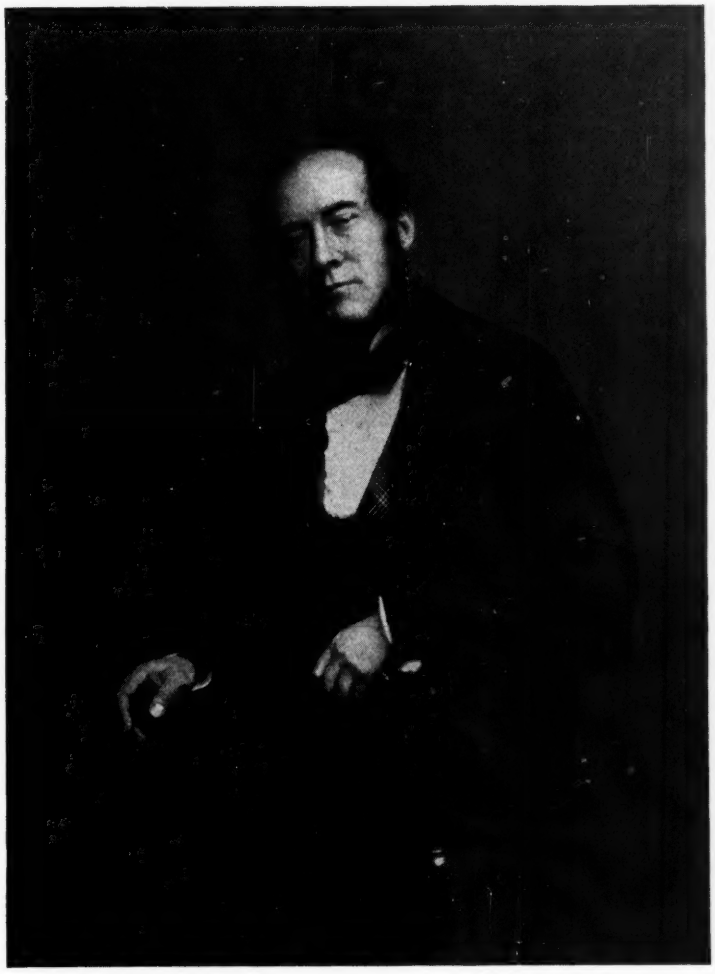
Whilst he was still living in Edinburgh, Fergusson became strongly imbued with the belief that it was often possible to preserve diseased tissues by careful operative procedure, and that it was especially desirable to do so in cases of joint disease, where it was the habit of his colleagues to amputate. In this he followed the sound teaching of Jeffray of Glasgow, Crampton in Dublin, and Roux in Paris. By precept and example he soon reduced the resection or excision of joints to a system, under the general title of 'conservative surgery.' He was amongst the first to excise the upper jaw; in 1845 he revived the operation of excision of the head of the femur; in 1847 he performed the operation of excision of the scapula; and from 1850 onwards he excised the knee as a routine procedure. Of excision of the upper or lower jaw, he says, "I have recommended the sitting posture as being the most convenient, for the blood is thus permitted to escape by the mouth. Sometimes a patient will faint, and must then be laid on his back—indeed, whether or not, it is always best to do so as soon as the disease has been removed. It has often happened that these proceedings have been retarded by sickness and vomiting; and, considering their severity, I need scarcely point out the propriety of having wine at

hand, contained in a vessel (such as a teapot) with a spout of sufficient length to permit the contents being poured into the back of the mouth."

Operations of this magnitude upon conscious patients could only be undertaken by men of great physical strength and immense dexterity, and it was in these two points that Fergusson and Liston excelled their colleagues, though the operating surgeons in days before the introduction of anæsthetics were always large and powerful men. Yet, with all his strength, Fergusson carried out to perfection the delicate operations for hare-lip and cleft palate. Of cleft palate he writes, " I need scarcely say that such an operation can be done only in the soft palate ; but should the fissure extend further forward, as it often does more especially in instances of hare-lip, the aperture in front can be afterwards closed with an artificial plate. Unless the patient is remarkably steady and determined to permit the operation to be finished, it will be needless to attempt it ; and as such fortitude is not to be expected before the age of puberty, it will seldom happen that the surgeon's services are required before this period. Even when he has finished the proceedings in a most satisfactory manner, he must not be over sanguine of a fortunate result. Every precaution must be taken to prevent movement of the palate ; the patient should partake of a meal immediately before the operation, and for the first two days should only swallow a little liquid, which he should allow to pass into the pharynx with the smallest possible drag on the stitches ; at other times he should not permit the saliva even to pass backwards. The stitches should be carefully cut out on the second or third day, and on no account whatever should he partake of solid food until all risk of the wound tearing open has passed away." From such small beginnings, Fergusson elaborated a complete operation, with division of the levator palati, and closure of the hard palate by osteotomy of the roof of the mouth.

Throughout his life Fergusson showed himself a first-rate demonstrator and surgeon, but never a good lecturer. He was an excellent colleague and true friend, ready to give credit where it was due, and free from the envy and self-seeking which marred the characters of too many of his generation. His name came early into public notice in connection with the murders committed by Burke and Hare in Edinburgh at the end of the year 1827. These miscreants murdered their victims to supply the anatomical rooms at Edinburgh. Robert Knox was willing to give the highest price for subjects, and it fell to the lot of Fergusson as one of the chief assistants to accept the bodies thus received. He shared this duty with his two colleagues, T. W. Jones and Alexander Miller. Feeling ran high ; Knox and his assistants were roundly abused, and were threatened with personal violence at the hands of the mob. In the end the assistants escaped, but the professional career of the master was ruined.

The portrait of Sir William Fergusson is from a photograph kindly lent by Sir Berkeley G. A. Moynihan, K.C.M.G., C.B.



SIR WILLIAM FERGUSSON.

From a photograph in the possession of Sir Berkeley G. A. Moynihan, K.C.M.G., C.B.

THE PATHOLOGY OF GUNSHOT WOUNDS OF THE SPINE AND SPINAL CORD.

By Colonel WILLIAM THORBURN, C.B., and Major GEORGE RICHARDSON, R.A.M.C.

Until the outbreak of the present war, our knowledge of the pathology of fractures and allied injuries of the spine was practically confined to that of simple fractures or 'fracture-dislocations' produced by the ordinary injuries of civil life, the most common form, and that which has been most fully investigated, being the type due to over-flexion of the whole back. Other injuries were in peace time regarded as unclassified rarities, and even in the wars of the last quarter of a century we know of no collection of pathological material illustrative of gunshot wounds. To a large extent our knowledge of fractures in general has been extended and modified during the last four years; but it can hardly be said that this applies to the spine, its investigation having been retarded by two main factors, the difficulty of obtaining satisfactory skiagrams, and the overshadowing of the bony lesion by the serious nature of the resulting visceral injury.

Under these circumstances it has appeared to us that it might not be without value to collect and compare a number of cases which we have investigated. The material at our disposal consists of post-mortem specimens prepared by one of us in a base hospital in France, and of operative findings by another of us in various theatres of war. The two series of cases are mutually illustrative, and although the exigencies of military service have rendered many of our notes very incomplete, and led to the loss of many records, we have endeavoured to give at least the outlines of a picture which may be filled in by others. The dried specimens to which reference will be made and which are here illustrated, have all been forwarded to the Museum of the Royal College of Surgeons of England.

In considering the conclusions arrived at, a few reservations must be made. The experience of the individual in war time is determined by his position in the war area, and may differ widely with his proximity to the front or to the base. All our observations have been made at advanced bases, the majority in a French seaport, others in Salonika, Mudros, or Malta, and a very few, during the early period of the war, in England. In effect, this implies that we have seen little of the most serious cases, which die before reaching the base, and even less of the least serious cases, which have been evacuated to England. Again, the actual conditions of warfare greatly modify the nature and frequency of the wounds produced. During the last seven months of open warfare in France we have seen a far larger proportion of injuries to the spinal cord than in the earlier days—a fact due partly, perhaps, to the absence of cover, and possibly also to the large proportion of rifle or machine-gun bullet wounds as compared with wounds from shells or bombs. It is at least probable that a great proportion of shell wounds of the spine never reached base hospitals. With regard to operative findings, it is also to be noted that as operations were performed in a very limited number of selected cases, they are in no sense illustrative of the comparative frequency of the lesions found.

On all these grounds we have thought it useless to attempt any estimate of the relative frequency of various types of wound, and we shall confine ourselves to a record of cases, dealing principally with injuries to the bones.

INJURIES TO THE VERTEBRÆ.

Certain general characteristics are at once apparent. While in civil life by far the most common injury of the spine is a fracture of one or more vertebral bodies, with displacement of the whole column, generally in the direction of flexion, our specimens show

very few in which the central mass is seriously involved, and none in which any angular curvature was or could have been produced. It must not, however, be concluded that direct impact upon the bodies of the vertebræ is as uncommon as here appears. Such direct impact will usually imply a coincident injury of thoracic or abdominal organs, and these cases would be little likely to arrive even in casualty clearing stations.

Another point which immediately attracts our attention is the wide distribution of fractures throughout several vertebræ, and the frequent presence of what we may call 'remote fractures'—of cracks and fissures well removed from the point of impact. Many of these remote fractures may be due to the general disruptive or divulsive action of gunshot wounds as seen in other regions ; but many are probably due to the wrenching away of bony prominences by the strong ligaments attached to them. In this way a powerful impact upon a single spinous process may blow it away, and carry in its course ligaments which, instead of themselves tearing, will wrench off fragments from their distal bony attachments. Hence we constantly find remote cracks and fissures such as are hardly met with in other regions of the body. The same tendency is shown in the remote fractures of spinous processes and laminæ accompanying ordinary 'fracture-dislocations,' and these widespread effects are almost characteristic of injuries to the spine.

We also note, as was to be expected, two types of fracture, often seen in different parts of the same specimen. On the one hand, we meet with abrasion, crushing, and perforation in areas subject to direct impact ; in many such cases bone is entirely pulverized and destroyed, the destruction being very marked in the case of the loose cancellous tissue of the bodies and lateral masses. On the other hand, we find clean cracks and fissures, often with little or no displacement of fragments, although it is practically certain that there has been at least a temporary displacement, associated with that *recoil* which is so marked a characteristic of spinal injuries, and which renders the visible osseous lesion little indicative of the seriousness of the crush inflicted upon subjacent nervous structures.

In connection with cracks and fissures, we may also note that, as each vertebra constitutes a bony ring, a fracture at any one point tends to be associated with a second fracture which will roughly lie diagonally opposite to it. It is thus rare to find a crack of one lamina only, although outlying processes may be detached by single fissures. It is also not very common for cracks and fissures to extend through the strongly-built pedicles ; injuries which might have produced such lesions expend their impact upon the loose cancellous tissue of the vertebral body near the seat of origin of the pedicle ; thus we have a 'seat of election,' the pedicle being wrenched away just below its base rather than split through its compact bony tissue (see ***Figs.* 412, 415, and 417**).

In connection with the osseous lesions, we may also note one or two points with regard to the ***lodgement of foreign bodies.*** In many cases these have completely transfixed the spine, and either lodged in remote parts or passed out through an exit wound. Skiagraphy is here of value in diagnosis, as the track of the missile can often be traced by bright spots due to minute fragments of metal left in its passage through the bone, and thus we can detect spinal injuries not otherwise recognizable during life.

Apart from such minute particles, impaction of metal fragments is not common in the arches and processes of the spine, but usually occurs in the bodies of the vertebræ or inside the vertebral canal. So far as the dense, brittle, and rounded processes are concerned, it is obvious they do not lend themselves to impaction, unless, as in *Case* **17 (*Fig.* 425)**, the fragment be of sufficient size and low enough velocity to become engaged between several processes. On the other hand, we have seen a good many cases of impaction, especially of shrapnel bullets, in the posterior part of the vertebral bodies. ***Figs.* 410** and **411** are illustrative, and others have been met with at operation. In some of these the bullet has apparently passed between the laminæ without producing any fracture thereof.

Lodgement in the vertebral canal has been met with rather frequently at operation ; but naturally such frequency is much influenced by the selection of cases. It is important in this connection to remember that a round smooth object like a shrapnel bullet may descend the canal. This is clearly shown in *Case* **5 (*Fig.* 412 *a* and *b*)**. In another case one of us removed a bullet from the lumbar canal which had twice previously been sought

for at too high a level; and we know of an instance in which an attempt to remove a bullet from the level of the first cervical vertebra resulted in its slipping downwards to the third. In all the cases which we have met with the bullet has slipped down inside the theca, and not between the theca and the bone.

On passing to the detailed examination of our specimens, we have found considerable difficulty in making any useful classification into groups; but we think that they may be regarded as falling under two main headings—viz., those in which the missile has impinged upon the spine at something approaching to a right angle, and those in which it has inclined to glance along or across the line of the vertebral column. Although recognizing that such distinction must be somewhat arbitrary, we shall therefore speak of (1) *Fractures by direct impact*, and (2) *Tangential fractures*.

We shall then find that fractures due to direct impact are divisible into those in which the missile has lodged in the spine, and those in which it has perforated and passed beyond it; while the 'tangential' fractures are again roughly divisible into those in which the wound runs along or parallel to the vertebral column, and those in which it tends to cross it at a wide angle.

1*a*. **Cases of Fracture by Direct Impact, with Retention of the Missile in the Spine.**—These vary from injuries which are almost trivial, so far as the bones are concerned, to those in which the damage is extreme; there being no necessary relation between the severity of the fracture and that of the injury to the cord.

Case 1 is an example of a perforating injury which is of the slightest possible extent. The patient died twenty-five days after injury. The right 5th cervical lamina presented a minute puncture. Beneath this was a small healed opening in the theca, which was here adherent to the spinal cord. At a slightly higher level, and lying under the 4th cervical lamina, a spicule of bone was embedded in the posterior fibres of the spinal cord, which were in part divided; while still higher a minute fragment of metal was embedded in the left side of the theca. The specimen from this case, to which we shall refer later, is in the College of Surgeons War Museum, and is not at present accessible to us.

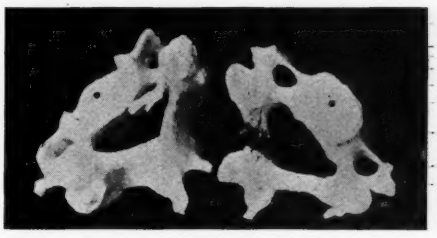


FIG. 409.—*Case* 2. The 4th and 5th cervical vertebræ. The 5th (right) shows fragment of metal *in situ*; the 4th (left) the depressed spicule of bone.

In *Case* 2 (*Fig.* 409) we find a similar condition of slight bony injury with severe damage to the spinal cord. A fragment of metal about the size of a dried pea has impinged on the upper margin of the right 5th cervical arch, where it remains lodged, making an aperture which will scarcely admit a lead pencil, but driving forward into the vertebral canal a fragment of bone half an inch long, which pierced the theca and partially divided the spinal cord.

FIG. 410.—*Case* 3. Metal embedded in body of 2nd lumbar vertebra. Incomplete fracture at base of spinous process.

Case 3 (*Fig.* 410) illustrates a condition which we have seen more often upon the operating table. A piece of metal has passed between the 1st and 2nd lumbar arches, and lies embedded in the middle line of the body of the 2nd lumbar vertebra. Before entering, it has slightly abraded the tip of the 2nd lumbar spinous process, and has caused an incomplete crack at its base; but, as in several cases of this type, there is no substantial injury of the laminæ, and operation would not have shown any fracture.

An example of impaction of a rifle bullet, which appears to be less common than that of shrapnel or

of irregular fragments, is seen in *Case* 4 (*Fig.* 411), in which the patient survived for a month, dying eventually from pneumonia and empyema. In the posterior part of the 7th dorsal vertebra is jammed the casing and part of the contents of a rifle bullet, the metal occupying the anterior half of the vertebral canal. Some fragments had entered the right lung and emerged through the right axillary line. The bullet appears to have entered the base of the spinous process on the left side, causing only very slight destruction of bone ; but a clean crack runs through the left upper articular process and the base of the right pedicle, so that almost the whole of the bony arch was detached, but left *in situ*.

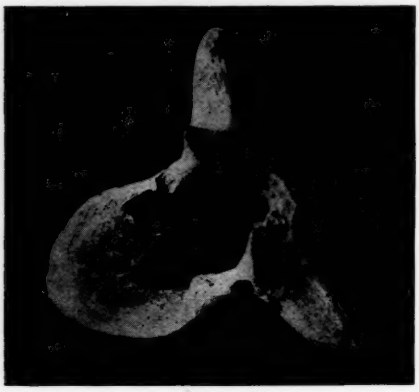
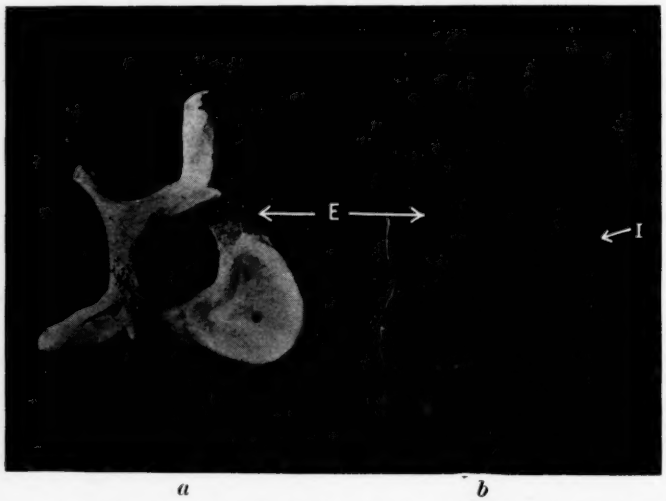


FIG. 411.—*Case* 4. Portions of rifle bullet embedded in body of 7th dorsal vertebra. The lead core is in the centre, with portions of casing on each side.

Case 5 (*Fig.* 412, *a* and *b*) shows equally through how small an aperture the vertebral canal is often perforated. A shrapnel bullet has slightly grooved the left pedicle of the 3rd dorsal vertebra, causing a crack which runs down just in front of the junction of this pedicle with the body. Crossing the vertebral canal, the bullet has then impinged upon and slightly abraded the right lamina, from which, rebounding, it has fallen into the canal. The theca was penetrated at the point of entrance on the left side, but not at the point of recoil on the right side. The bullet thus lay inside the thecal canal, and had fallen downward an inch and a half from its point of entry. The cord shows two points of crushing (*Fig.* 412, *a*), one at the point of entry, and the other about a quarter of an inch lower down at the point of reflection.

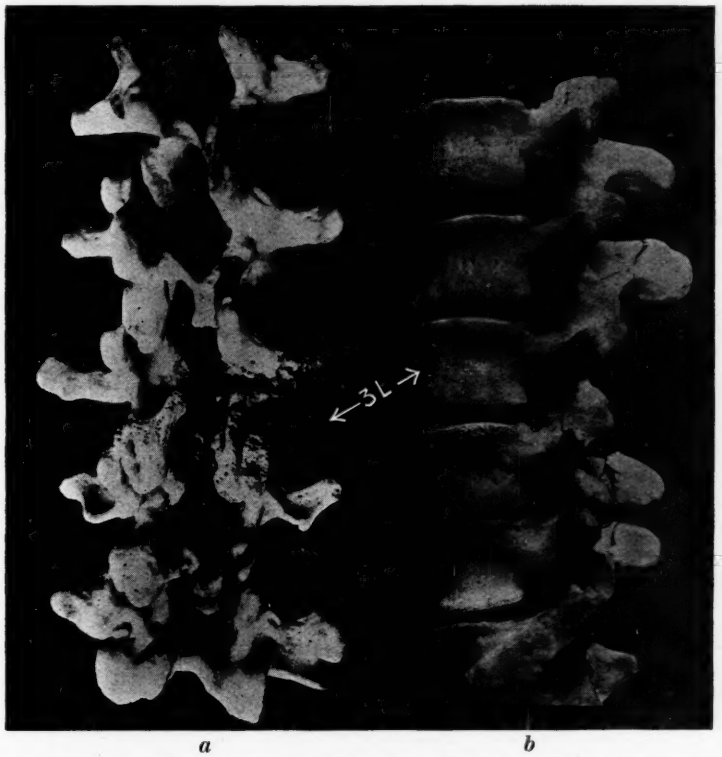


a *b*

FIG. 412 (*a*, *b*).—*Case* 5. (*a*) The 3rd dorsal vertebra. Point of entry of bullet is seen at left pedicle ; point of impact was at opposite side. (*b*) Shows the theca and cord ; a shrapnel bullet is seen low down on the left side. (E) Point of entry. (I) Point of impact.

Case 6 (*Fig.* 413, *a* and *b*) is in strong contrast with the above. The wound, due to an expanding rifle bullet, has been received over the 3rd lumbar vertebra. The spinous process and laminæ of that vertebra are completely pulverized, and its right transverse process is blown away ; large splashes of lead occupy the bony masses of the superior and inferior articular processes on the right side. Another piece of lead and part of the casing

lie in the back of the body of the vertebra. This specimen presents also numerous remote bone injuries. Extensive cracks separate two large pieces from the spinous process and



a *b*

FIG. 413 (*a*, *b*).—*Case* 6. (*a*) Lumbar spine. Extensive bony damage and scattered fragments of metal. (*b*) Is a lateral view showing extent of bony damage.

articular process of the 2nd lumbar vertebra, and a crack runs through the base of the left pedicle of the 3rd. The spinous processes of the 4th and 5th, and the upper articular process of the 4th, are detached. So extensive an injury can hardly have been due to direct impact, even by fragments of an expanding bullet, and the result is probably due to impact upon the strong spinal ligaments, which have torn away outlying processes above and below the seat of impact.

FIG. 414.—*Case* 7. Cervical spine. Fracture of 5th and 6th arches.

1*b*. **Cases of Fracture by Direct Impact, with Complete Perforation of the Spine.**—These resemble the previous group in the great variations in the severity of the injury. In some this is extraordinarily slight, and would hardly seem commensurate with the severe effect produced; in others there is much bony damage, which again may be localized to the region of direct impact, or may be associated with cracks and fissures at a distance therefrom.

Case 7 (*Fig.* 414) is illustrative of the slightest form of bony lesion. The patient was admitted to hospital in a dying condition, with a much-distended abdomen and a lodging wound with gas gangrene of the right thigh and buttock. No spinal injury was suspected, but death

occurred within an hour of admission. At the post-mortem examination, the distention of the intestines and bladder without any signs of inflammation led to a careful examination of the spine. There was found a minute penetrating wound, with entrance behind the left sterno-mastoid muscle, and exit on the right side at the same level. On laying this open there was exposed a fracture of the left arches of the 5th and 6th cervical vertebræ, with no displacement of bone, although fragments as shown in *Fig.* 414 were separable after maceration. Around the untorn theca was some blood-clot, and the spinal cord showed a central hæmorrhage. It is clear that we have here a case in which the two small bony fragments were momentarily displaced, but recoiled to their original position. It is, however, very doubtful whether this case should be regarded as having arisen from a direct impact or from a tangential blow.

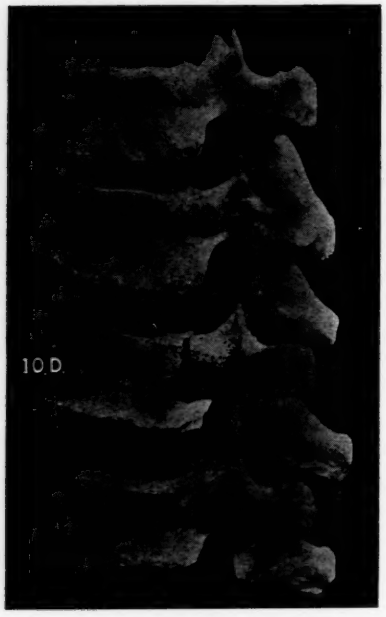


FIG. 415.—*Case* 8. Showing point of exit of shrapnel bullet through pedicle and body of 10th dorsal vertebra.

Case 8 (*Fig.* 415) illustrates a more common condition, in which the wound has passed directly through the spine. A shrapnel bullet entering the right loin, and coming to rest below the left kidney, has passed through the right 10th and 11th dorsal articular processes, and outwards through the pedicle of the 10th dorsal vertebra. The holes of entry and of exit are very cleanly drilled through the soft bone here encountered, but there is a crack through the right 10th dorsal pedicle and through the remains of that of the left side, so that the entire bony arch of the injured vertebra was separable, although retained in position. The theca and spinal cord were completely cut across.

Closely similar is *Case* 9 (*Fig.* 416), in which a rifle bullet passed from the right side of the neck through the 4th and 5th dorsal vertebræ and left scapula. Impact has here occurred on the right side of the body of the 4th dorsal vertebra, of which part is pulverized, while the left half of the 5th dorsal vertebra, with its pedicle, and the transverse process of the 6th, are also lost. There is a long crack, without displacement, through the spine of the 5th. The theca would clearly lie away from the track of the bullet, but it presented a small tear behind the 5th cervical vertebra, and the spinal cord was diffluent over a wide area.

The two following cases differ from those already described, in that the wounds inflicted are less sharply drilled through the bones and are associated with more extensive splintering.

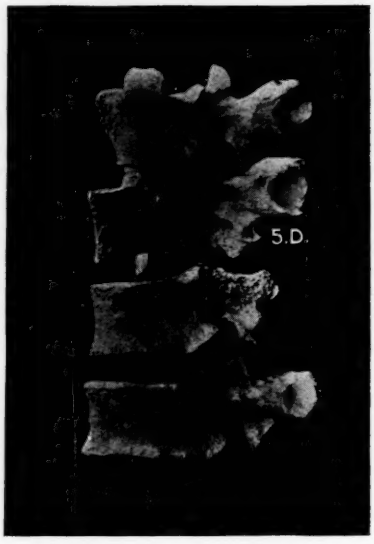


FIG. 416.—*Case* 9. Destruction and loss of substance of body of 5th dorsal vertebra.

In *Case* 10 (*Fig.* 417), the missile, of which the nature is unknown, had passed through the right lung and the liver, impinging on the body of the 11th dorsal vertebra. It here passed through the front of the right lamina; but instead of completely pulverizing the soft bone, it has blown out two more or less triangular fragments. It then destroyed the left arch. Subsidiary cracks involve the spinous process of the 11th dorsal vertebra, the superior articular process of the 12th,

and the 'seat of election' in front of the right lamina of the latter, all of which are probably due to the indirect impact from the vertebra above.

Still more marked is the extensive fracture in *Case* 11. A rifle bullet, passing through the apex of the right lung and the trachea, has penetrated the bodies of the 2nd and 3rd dorsal vertebræ, passed on between the 3rd and 4th, and made its exit a little to the left of the 4th dorsal spine. The extensive secondary injuries are best appreciated from the annexed photograph (*Fig.* 418, *a* and *b*).

Looked at from the front, we see: (1) Three large separated fragments of the 2nd dorsal body, with a hole between them; (2) A similar condition of the 3rd dorsal vertebra; (3) A vertical split down the centre of the body of the 4th dorsal. From behind, we see that the bullet in its descending course has spared the laminæ and spine of the 2nd dorsal, but has blown away the spine and fractured both arches of the 3rd. It has also broken three large fragments of the left lamina, the arch, and the spine of the 4th dorsal vertebra.

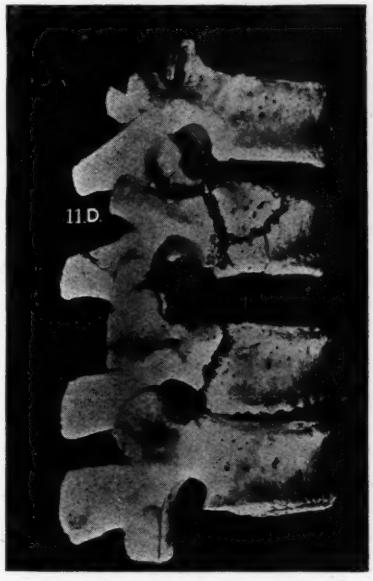
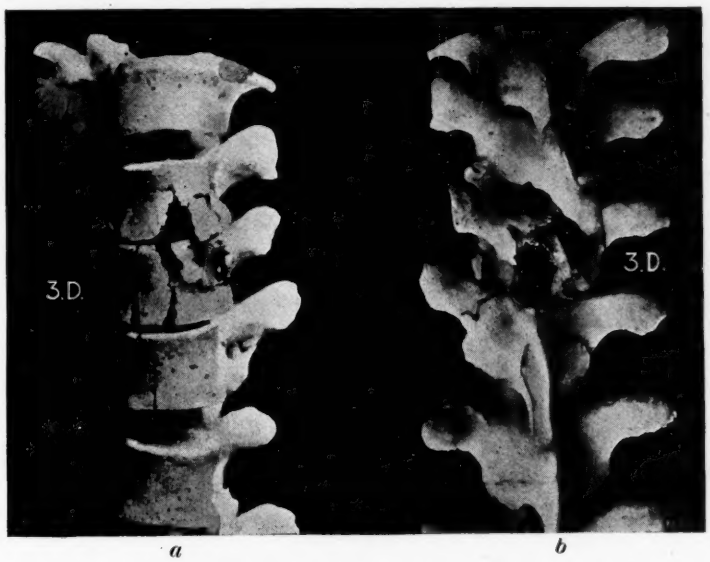


FIG. 417.—*Case* 10. Fracture of body of 11th dorsal vertebra, and fracture of 12th dorsal at 'seat of election.'



a *b*

FIG. 418 (*a*, *b*).—*Case* 11. (*a*) Shows the entry wound at the bodies of the 2nd and 3rd dorsal vertebræ. (*b*) Shows the exit wound, involving chiefly the 3rd dosal vertebra.

2. Cases in which there has been a Tangential Blow upon the Spine, and in which the Vertebral Canal is, as a rule, not penetrated, either by the Missile or by Fragments of Bone.

Case 12 (*Fig.* 419) is an example of the slightest degree of this type of injury. The patient was admitted with paraplegia and anæsthesia extending upwards to about midway between the pubes and the umbilicus, and with abdominal symptoms for which a laparotomy was performed. The abdomen contained a quantity of blood, and the

intestines were distended. The patient became so collapsed that the operation was not completed, and death occurred very shortly afterwards. The autopsy showed that a machine-gun bullet had entered to the left of the lumbar spine, and come to rest in the right lobe of the liver. The left inferior articular process and the spinous process of the 11th dorsal vertebra had been carried away. The theca was uninjured, but at the level of impact the spinal cord was so much destroyed and thinned as to be almost divided.

Case 13 (*Fig.* 420) is a more severe example of a similar condition. A rifle bullet had entered the back of the neck on the left side, and was

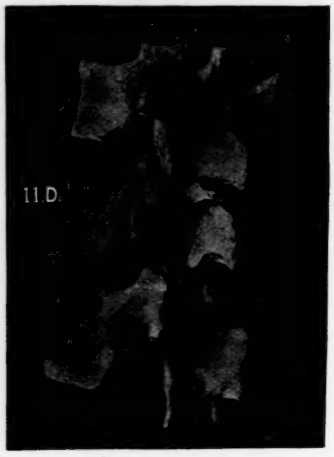


FIG. 419.—*Case* 12. Slight injury to spinous and to left inferior articular processes of 11th dorsal vertebra.

FIG. 420.—*Case* 13. Injury to right side of 3rd cervical vertebra.

resting subcutaneously on the right side of the neck, having struck the 3rd cervical vertebra in its passage. The 2nd and 4th cervical vertebræ are quite uninjured. As regards the 3rd, the spinous process, with the lower margin of the left lamina, the lower right articular process, and the right transverse process, are all blown away. There is no narrowing of the vertebral canal, and no loose bony fragments were found therein ; but the theca was widely torn and the spinal cord crushed at the site of the lesion.

The two following cases differ in that the tangential blow has taken a vertical rather than a horizontal direction.

Case 14 (*Fig.* 421) was admitted with a wound over the left shoulder, and presented a metal fragment lying opposite the middle of the left sternomastoid muscle. From the left transverse process of the 6th cervical vertebra has been blown away a small fragment of bone, opening the foramen for the vertebral artery. The 5th cervical vertebra shows a more extensive destruction, due to several clean cracks involving the bulk of the lateral mass. In the 4th vertebra, the lower articular process is blown away. In the 3rd, the lateral bony mass is completely detached by clean fissures, but is not displaced ; in this vertebra there is also a clean fracture through the right lamina. There was a small amount of blood-clot around the theca, but the latter and the spinal cord showed no macroscopic change, although, as we shall see hereafter, there was a hæmatomyelia at the seat of injury (*Fig.* 422).

Case 15 (*Fig.* 423) is also an example of an extensive glancing blow. The missile entered above the middle of the posterior border of the right sternomastoid muscle, and escaped from the left side through the outer end of the supraspinous fossa of the scapula. Five vertebræ are affected, as follows : In the 5th cervical there is a separation of the spinous process, and a small crack in the right transverse process. In the 6th cervical

the spinous process is destroyed down to its base, while there is a small crack in the right lamina. The 7th cervical shows still more complete destruction of the spinous process

FIG. 421.—*Case* 14. Injury to 3rd, 4th, 5th, and 6th cervical vertebræ. The injury to the spinous process of the 7th is an artefact.

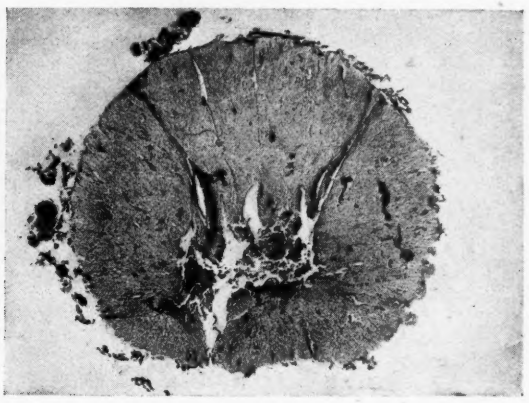


FIG. 422.—*Case* 14. Section showing area of maximum hæmorrhage.

and of the inner aspect of the lamina. The 1st dorsal has a long horizontal crack across the lamina, so that a large part of the right lamina, with the spinous process, is separated, although not displaced. Finally, the 2nd dorsal vertebra presents a fracture through the outer end of the left lamina. The oblique track of the missile is thus clearly shown, the main impact having occurred about the base of the 7th cervical spinous process, where a small fragment of metal is embedded. At this point minute fragments of bone had been driven inwards and had lacerated the spinal cord.

In *Case* 16 (*Fig.* 424, *a* and *b*), although, as stated in the post-mortem notes, "the vertebral column was almost completely divided and the cord cut across," it is probable that the spine was not directly struck, but that the fractures were produced by the carrying away of the soft parts, this causing the tearing off of portions of the vertebræ and rotation of the whole spine. The wound was a large, deep laceration, running across the upper and middle dorsal regions. The right lung was lacerated. The body of the 3rd dorsal vertebra presented a complete vertical split through its centre, and this sagittal crack is associated with another one at the opposite pole of the vertebral ring, running through the right lamina, and thus dividing the whole bone into two almost equal halves. The vertebra above shows some tearing away of bone from the left transverse process and the under part of the spinous process, while the

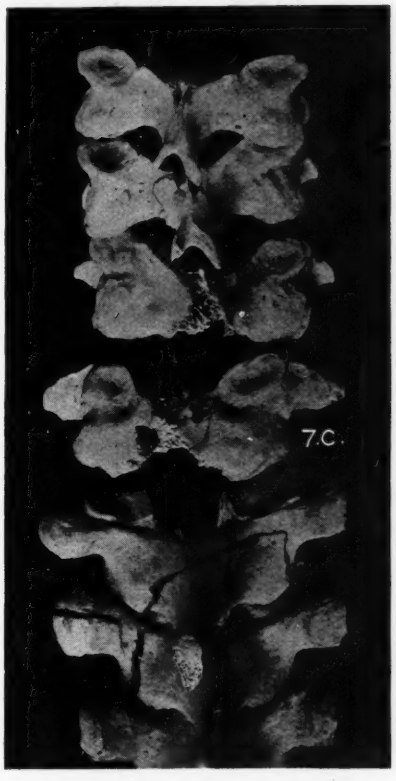
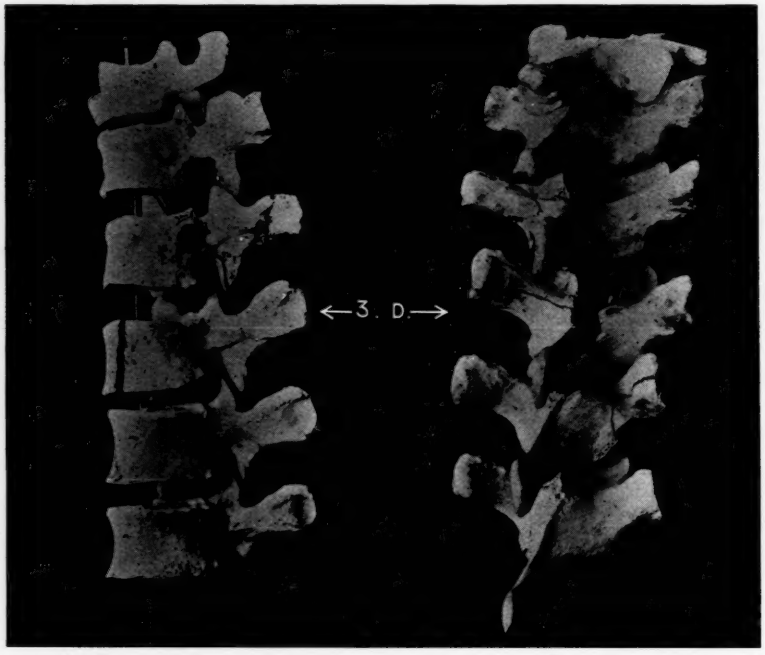


FIG. 423.—*Case* 15. Cervico-dorsal spine. Very extensive bony damage.

vertebra beneath shows cracks in the right transverse process where the spine of the 3rd dorsal vertebra has impinged in the course of its violent rotation. It is noticeable that, although the extent of fissuring is here much less than in many of our cases, this is the only instance in which the continuity of the vertebral column was interrupted. The heavy lateral blow has produced rotation of a vertebra and tearing of the intervertebral discs, but is associated with comparatively little injury to the outlying processes, and with most severe crushing of the spinal cord; it thus recalls the effects of fracture-dislocation as ordinarily seen in civil practice, and the results have been produced by the same massive force exerted indirectly through the soft parts.



a *b*

FIG. 424 (*a*, *b*).—*Case* 16. (*a*) Vertical split of body of 3rd dorsal vertebra. (*b*) Is a reverse view, showing fairly extensive fissuring.

Case 17 (*Fig.* 425) shows an unusual form of injury to the spine, in which the contents of the vertebral canal were almost uninjured, but death was due to hæmorrhage from the vertebral artery. The patient was admitted with a wound of the left cheek, from which free oozing of blood was controlled by packing. He also complained of some

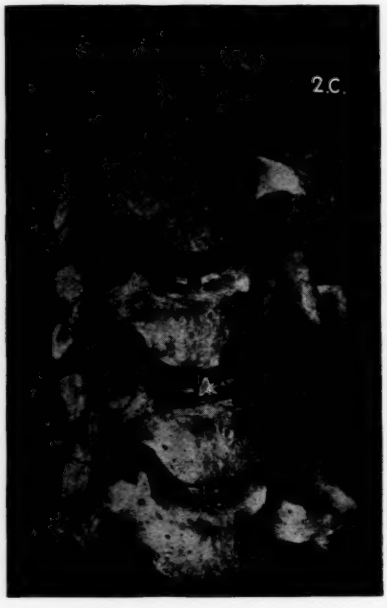


Fig. 425.—*Case* 17. Cervical spine. Metal *in situ*.

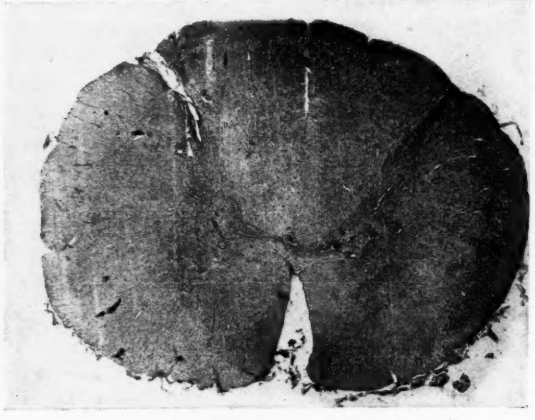


FIG. 426.—*Case* 17. Section of spinal cord with very localized hæmorrhage in left posterior cornu.

tingling in the left arm, but no other symptoms were noted. A week later there was sudden violent bleeding from the mouth, and death ensued in fifteen minutes. At the autopsy was found a metal fragment about the size of a large hazel-nut which, having perforated the lower jaw just in front of its angle and passed downwards and inwards through the root of the tongue, had come to rest in front of the 4th and 5th cervical vertebræ. The vertebral foramen of the 4th vertebra was laid open (see *Fig.* 425), and the transverse process cracked across. The 5th cervical showed a crack in front of the pedicle involving the body (seat of election), and cracks, without displacement, of both laminæ. The vertebral artery was ulcerated through at the level of the 4th cervical. The theca showed no abnormality, but in the spinal cord there was a minute hæmorrhage, smaller than a pin's head, occupying the left posterior horn (*Fig.* 426).

INJURIES TO THE THECA SPINALIS.

But little remains to be added to the remarks already made upon the condition of the spinal meninges in the above cases. It is throughout noticeable that, unless subject to direct impact of missiles or of bony fragments, the membranes are untorn even in cases in which the spinal cord is fatally injured—a condition quite analogous with what is found in the injuries of civil life. Tears in the theca, when present, show little or no tendency to retraction of their edges, and, just as in operations this membrane is most easily closed, so in injuries it seldom presents any large aperture. It is probably for this reason that the escape of cerebrospinal fluid from wounds is very rarely noted. Such escape often follows operations or accidental stabs and incised wounds ; but the swelling or displacement of parts in a gunshot wound appears to be quite sufficient to arrest it, the arrest being doubtless also due in part to adhesion of the membranes to the cord, a condition rarely if ever seen in aseptic injuries, but noticed in several of our cases. As is well known, the spinal dura mater, like that of the brain, is peculiarly resistant to infection from without, and meningitis was never met with except when there was gross perforation of the theca, and generally in the presence of a foreign body. Hæmorrhage around the theca is common, and in cases of late date we have several times found at operation a considerable amount of perithecal cicatrix, which appears to be capable of exercising pressure upon the subjacent cord. On the other hand, we have not met with any substantial hæmorrhage within the theca, although there can be little doubt that it occasionally occurs. No operations upon old-standing cases have shown adhesions between the cord and its membranes.

INJURIES OF THE SPINAL CORD.

We have already seen how seriously the cord may be injured even when the osseous lesion is of only slight degree or has been associated with immediate recoil of any displacement (*Cases* 1, 2, 7, 17, and 14), and the following are further examples of the same condition.

Case 18 was admitted with complete paraplegia due to a wound of the neck. An *x*-ray examination showed comminution of the 4th and 5th cervical arches on the right side, where a piece of metal lay outside the spine. Respiration was greatly embarrassed, and was failing rapidly on the third day, when operation was performed. The theca when exposed showed no signs of pressure, but presented a very slight scratch on the right side. Being otherwise quite normal, it was unopened. Death ensued from respiratory failure. The condition of the spinal cord is shown in *Figs.* 427, 428, and 429.

Case 19 was admitted with paraplegia due to a wound in the neck, " a foreign body having been removed from under the ligamentum nuchæ." The paraplegic symptoms, which were almost complete below the neck, persisted with but little change, except that some vague deep sensation was felt on the right side of the trunk and right thigh, while cystitis with pyrexia was directly threatening life. A skiagram showed no vertebral

injury. On the twenty-third day operation revealed merely some tearing and blood-staining of the interspinous ligament between the 4th and 5th cervical spines. Laminectomy, with exposure of two inches of the theca, showed no abnormality. Death occurred four days later from infection of the urinary tract, with multiple renal abscesses. At the post-mortem examination, the cord and membranes were quite normal to the naked eye, but on section the appearances shown in *Fig.* 430 were found.

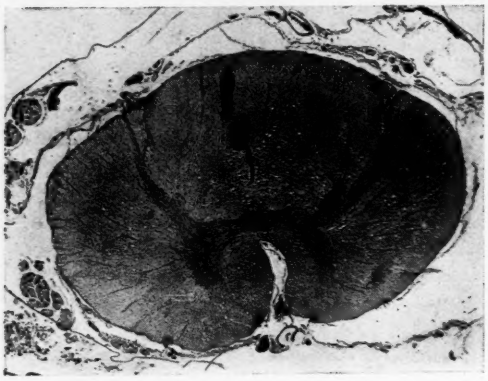


FIG. 427.—*Case* 18. Section of cord above area of necrosis, showing four large hæmorrhages.

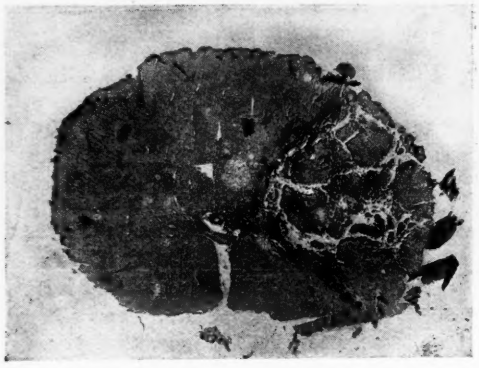


FIG. 428.—*Case* 18. Extensive area of hæmorrhagic necrosis.

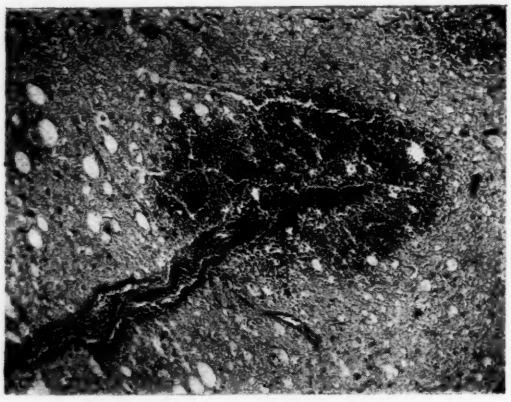


FIG. 429.—*Case* 18. Higher magnification of part of *Fig.* 427, to show a hæmorrhage.

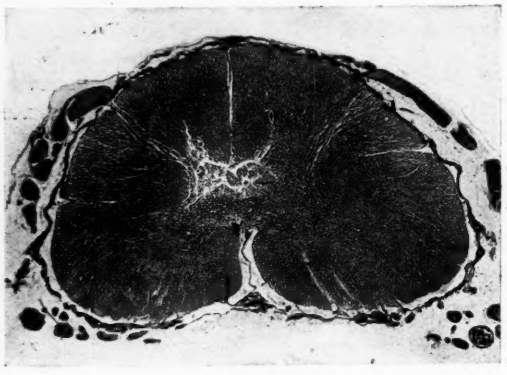


FIG. 430.—*Case* 19. Area of necrosis almost central.

Case 20, admitted with paraplegia below the mid-dorsal region; died twenty-four hours later. The post-mortem examination showed that a fragment of shell had passed from left to right, abrading the spine of the 9th dorsal vertebra, not otherwise injuring the vertebral column, but coming to rest against the head of the 9th rib, which was fractured. There was some blood-clot around the theca at the level of the injury, and some congestion of its vessels. The uncut cord was normal to the naked eye, but on section revealed hæmorrhages and other changes similar to those found in the previous case (*Figs.* 431, 432).

In cases of this type, which are often spoken of vaguely as cases of concussion of the spinal cord, the bruising and hæmorrhage is clearly not always due to osseous displacement, whether with or without recoil, and must have more often resulted from the general disruptive or divulsive wave which is characteristic of gunshot injuries in all regions. The appearances are, however, very uniform, and closely similar to those produced by direct crushing of the spinal cord.

Serial sections show to the naked eye a spindle-shaped area of petechial hæmorrhage with necrosis, extending throughout two or three segments of the cord, most marked at the point of impact or of the divulsive wave, and thence tapering off both upwards and

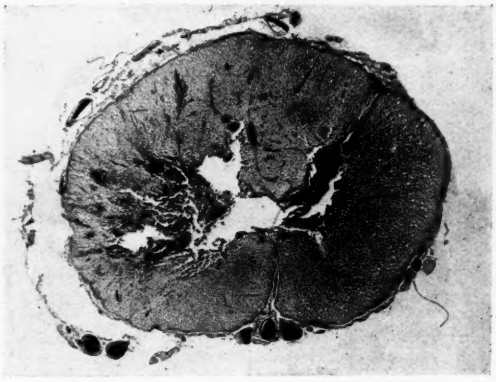


FIG. 431.—*Case* 20. Numerous hæmorrhages and extensive necrosis.

FIG. 432.—*Case* 20. Portion of lateral column seen in *Fig.* 431, highly magnified to show sieve-like structure of the white matter and some swollen axis cylinders.

downwards, the upward prolongation being as a rule longer and more tapering. We thus have two cones of destruction, united at their bases, and the lower generally much more truncated than the upper. In the whole of this area the destruction tends to be more marked in the central grey matter than in the firmer and less vascular lateral fibres. The medullary substance is completely disintegrated, and intermingled with it are numerous small areas of extravasated red blood-corpuscles. Around this hæmorrhagic area is a certain amount of œdema, affecting especially the axis cylinders (*Fig.* 432), and associated with Nissl degeneration of the anterior cornual cells. Intra-radicular hæmorrhages were also occasionally found. We were unable to detect any evidences of reparative changes, even in such an instance as *Case* 19 (*Fig.* 430), where the patient survived the injury twenty-seven days.

It will be obvious that the changes here described, and resulting from impact of minute fragments of bone or of the disruptive wave of a gunshot injury, are all of the nature of contusions of the spinal cord ; and that although they are sometimes spoken of as 'concussion,' they have little or nothing in common with the lesions which may be produced by heavy falls and blows, or by proximity to explosions, in which we have a generalized rather than a localized effect. We have seen numerous cases in which gunshot injury of the back is accompanied by more or less complete paraplegia which tends to recovery, but we have no pathological evidence as to the changes produced in such cases. We can only surmise, without being able to prove, that they also are due to minute hæmorrhages resulting from the divulsive wave. The nearest approach to confirmation of this view is furnished by *Case* 17, in which the sole nervous symptom was 'numbness' of the left arm, and the sole pathological appearance a small hæmorrhage in the left posterior root. Had this patient not died from other causes, it would have been impossible to prove the existence of this minute injury.

RESTORATION OF THE URETHRA BY MEANS OF BAER'S MEMBRANE.

By Captain JOSEPH E. ADAMS, R.A.M.C.T.

The following case of gunshot wound of the urethra is of interest, by reason of the ease with which a distressing condition has been relieved, and the degree of success which has attended the operation. It is true that there will be some permanent stricture along the course of the urethra ; but this is certainly preferable to the degradation, to the male mind, of micturition via the perineum, and it can be controlled by the regular use of sounds.

Private S., age 22, was wounded Nov. 27, 1917, by a fragment of shell which entered through the perineum and emerged above the pubes at the root of the penis. There was a large ragged wound between the legs, involving the scrotum, but the wound of exit was small. Healing took place slowly, and both wounds were not closed until February, 1918. The testicles were not damaged, there was no bony injury, and the bladder was not involved in the wound.

When I examined him in April, the penis was shortened, and approximated to the abdomen by a recently healed cicatrix over the pubes. All his urine was voided through a fistulous opening behind the scrotum, and a catheter could easily be passed through this into the bladder. A sound could be passed about one inch down the urethra from the urinary meatus, but no further. It was therefore clear that the urethra between these points was seriously damaged, if not destroyed. It seemed rather improbable that it could be restored by operation ; and my own experience of operations for hypospadias, either by simple plastic operation, or by vein-grafting from the internal saphenous, had been so unsatisfactory that I made no promise to the patient except that I would endeavour to restore the urethral channel. He was quite ready to accept the risk of failure, and is consequently more than delighted with the success of the operation.

Operation, April 22.—The lithotomy position was used. A director was passed from the perineal fistula into the bladder, and a sound from the urinary meatus to the scar tissue in the body of the penis. The scrotum was next split down to the proper level of the urethra, of which practically no trace could be found. Scar tissue was removed, the two ends of the urethra were dissected free for about half an inch, and the edges were freshened for the application of the sutures to hold the new urethra of Baer's membrane.

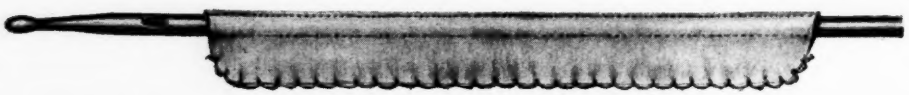


Fig. 433.– Artificial urethra, constructed by sewing a piece of Baer's membrane round a catheter.

This was next constructed by sewing a piece of membrane* round a No. 9 English gum-elastic catheter—very loosely in order to allow of subsequent contraction—as shown in *Fig.* 433. The total length of the gap in the urethra was five inches, and the artificial one was therefore made about three-quarters of an inch longer, so that it might be invaginated for a short distance into the urethral ends and fill the gap without tension.

* The Baer's membrane used in this case was that prepared by Johnson and Johnson, of New Jersey. It is described by the makers as 'chromatized medium-hard,' and prepared in accordance with the suggestions of Dr. Wm. Stevenson Baer. After removal from its sterilized envelope it was merely soaked in sterile normal salt solution for five minutes before use.

I am indebted to the theatre sister for the care with which this membrane was sutured around the catheter, and it should be noted that it was designed to be of nearly three times the actual diameter of the catheter, except at its ends, where it fitted more closely. Its edges were approximated by a single running iodized catgut button-hole suture.

The artificial urethra was next put in position by passing the catheter from the meatus into the gap, through the membranous tube, and then through the posterior opening of the urethra into the bladder. Care was taken to apply the sutured edge of the tube to the deep aspect of the wound, i.e., towards the dorsum of the penis, since it was thought that this would tend to prevent leakage; the ends were invaginated into the two open mouths of the urethra, and were secured here by several catgut stitches, which in places penetrated the membrane owing to its thinness.

The next step consisted in dissecting up a flap of soft tissue from each side of the floor of the wound rather greater than the length of the urethral gap, both from penile and scrotal tissue, as is done in plastic operations for hypospadias; interrupted catgut was used to secure this second channel over the artificial urethra so that its suture line lay over the unbroken surface of Baer's membrane. Hæmostasis being secured, the skin was closed with interrupted sutures of salmon-gut, leaving two small rubber drains at the anterior and posterior limits of the wound. In order to avoid risks of leakage of urine during the healing process, the bladder was next filled by means of the catheter already *in situ*, and suprapubic drainage by a Guyon's tube carried out. The catheter was then fixed in position by adhesive strapping, and sutures passing through the prepuce.

Post-Operative Course.—All the urine drained by the suprapubic route for the first eleven days. The rubber drainage tubes were removed on the fourth day, and the wound healed by first intention, except at two points close to the ends of the true urethra. At both these points there was slight leakage of urine,—enough to demand daily dressing for a few days—but the posterior sinus healed about a fortnight after operation. The Guyon's tube was removed on the twelfth day, and the urine then drained away by the catheter, to which a long rubber tube was attached. A small slough was removed from the anterior sinus on the fifteenth day, and the catheter was finally taken out eighteen days after operation. It came out with perfect ease, and there was no sign of its being gripped at any point by scar tissue. The urine remained normal throughout. There was a small slough about $\frac{3}{4}$ in. in length around the catheter close to its bladder end, and I think this represented a very small portion of the Baer's membrane. Normal micturition followed the removal of the catheter, but the anterior sinus leaked for several weeks. To aid the closure of this, a No. 6 silver catheter was passed under anæsthesia and tied in for four days, the edges of the fistula being freshened and approximated with a couple of catgut sutures. Six weeks after the first operation the patient was again examined under an anæsthetic, and a 20–24 Clutton's sound was passed easily. Urethroscopy revealed no definite stricture at any part of the urethral canal, but the walls were abnormally vascular, though quite smooth. Two days later the fistula was healed, but it has broken down once or twice since, after larger sounds have been passed. On Nov. 4 a 26–30 Clutton's sound was passed under chloroform anæsthesia, and since that date sounds have been passed at regular intervals without the aid of an anæsthetic. The patient is now (December, 1918) able to pass size 18–22 himself. As soon as he is able to pass a 20–24, I propose to provide him with his own sound, and he will be ready for discharge, provided he promises to pass the instrument regularly at short intervals. He has already shown that he understands the principles of asepsis.

My own experience of the simple plastic operation commonly recommended for the treatment of mild cases of hypospadias has been disappointing, and in selecting Baer's membrane to protect the suture line, I was influenced by the statements concerning its value in arthroplasty, where it is said to undergo organization into tissue corresponding to that which it replaces.

I considered the advisability of utilizing a tube of his own fascia lata, or the internal saphenous. I decided against the latter because I am convinced that it is essential to

provide a wide channel, and I have found that an excised vein, when emptied of its blood, becomes a very narrow tube. Baer's membrane probably possesses an advantage over fascia in that it is already 'shrunk': though I must confess that hitherto I have favoured the use of autogenous rather than heterogenous grafts in arthroplasty and similar operations.

I feel sure that success in such cases depends on providing at least two layers of tissue to resist leakage of urine, and also on drainage of the bladder above the pubes for a considerable time. It was rather surprising to find that, with the Guyon's tube and catheter both in the bladder, all the urine drained by the suprapubic route and none came through the urethral catheter. Within three days of the removal of the suprapubic tube this opening had closed and all urine was voided by the catheter. I shall certainly adopt more careful precautions against leakage of urine in operations for congenital deformities of the penis and urethra in future, and it seems important to insist on suprapubic drainage as an essential step towards success in these operations. The restlessness of a child patient must certainly be guarded against, as it is easy to dislodge these tubes.

I should like to conclude this short article with a tribute to the wounded British soldier, who is the best type of surgical patient I have ever had to deal with.

My thanks are due to Colonel H. P. Hawkins, commanding the 5th London General Hospital, for his permission to publish this case.

THE TREATMENT OF FUNCTIONAL DISABILITY OF THE LIMBS IN A SPECIAL MILITARY SURGICAL HOSPITAL.

By Lieutenant WM. CUTHBERT MORTON, C.B.E., R.A.M.C.

Officer in charge of the Re-education Department of the 2nd Northern General Hospital, Leeds.

FOREWORD.

The functional hospital is a paradise in which, as Antonio would say, the healer is "a spirit of persuasion" and the patients "take suggestion as a cat laps milk." The special surgical hospital, on the other hand, is a combined purgatory and inferno in which the functional healer is kept humble by the slow and imperfect results of his treatment and only too often is tormented by its absolute futility. In the functional hospital it may be possible to cure in the first sitting a score or two of consecutive cases, but in the special surgical hospital he would be fortunate indeed who should cure five which were not deliberately selected.

In March, 1917, the writer was appointed to take charge of the massage department of the 2nd Northern General Hospital, and it was not long before he became convinced that massage and electricity were of little or no benefit—and indeed on occasion were positively harmful—in certain cases which should nevertheless be cured or at least improved by intensive training. Thus, a man who had been in the hospital for four months was still closing his hand by extension of the first and flexion of the second and third phalanges; yet a simple demonstration of the muscular mechanism of the disability brought about closure by full flexion within forty minutes; and although at first the movement was cautious and slow, he soon regained complete control. Again, a man who had for some time been trained elsewhere by one of the best of our masseuses was, after twenty months of hospital life, still going about on crutches with a knee rigidly extended and a profoundly flaccid foot; yet after fifteen minutes' training he was able to walk perfectly without support.

After a few months in the massage department, the writer was asked by Lieutenant-Colonel Littlewood, Officer Commanding the 2nd Northern General Hospital, to undertake the training of five or six cases for a few weeks in order to see what could be done along these lines; and out of this small beginning grew the re-education department of the 2nd Northern General Hospital. Although from the outset the importance of this kind of work has been recognized, and much interest has been taken in the department by the authorities, yet the demands on the hospital have been so great that it has never been found possible either to house or to staff the department adequately.

At first the patients were grouped together in a ward (which was, however, shared with a surgeon), and out of the few cases of general 'shell shock' which we then had, several did very well indeed; but partly, perhaps, because we had not yet gained sufficient confidence in the methods of treatment which we were then only evolving, chiefly no doubt because of the large proportion of cases in which the training was hampered and prolonged by organic trouble, it was impossible to create an 'atmosphere,' and the men were once more scattered among the surgical cases throughout the hospital, attending the re-education department as out-patients. In a functional hospital the atmosphere appears to be everything; but in a special surgical hospital it is out of place for all cases in which organic and functional disabilities are closely interwoven, although it may be desirable for those whose disability has become purely functional. The procedure now adopted is as follows.

Admission into Hospital.—Patient is admitted into and retained in one of the surgical wards under the surgeon's care, except that some of the pensioners are treated throughout as out-patients.

Reference to the Re-education Department.—After the surgeon has completed his examination, he refers the patient to the re-education department if he thinks that part of the disability may not be organic. All cases so referred are welcomed, since at times treatment is the only means of deciding how much is purely functional, and even if the case is purely organic something can always be learned from it. Each patient is examined for the first time privately, and no one is ever treated in such a way as to lead him to think that his disability is not regarded as a very real thing. It is quite possible to conduct the examination without giving rise to any unfortunate 'suggestion.'

Complaint and Previous History.—Patient explains what he cannot do, and is then asked about anything previous or subsequent to the disability which may have any bearing on the case—as, for example, whether he has had the trouble before, or suffered from paralysis as a child, whether foreign bodies have been removed or are still present, and so on.

Appearance of the Limb when Patient is at Rest.—The limb is examined for œdema, scars, deformities, abnormal postures, involuntary movements, and the like.

Disability in Voluntary Movement.—The movements which the patient cannot voluntarily execute in a perfectly normal manner are noted. The whole limb should be examined in every case, since in drop-foot, for example, the leg and thigh may also be involved so that weakness of abduction at the hip-joint may have caused the pelvis to drop on the other side.

The Muscles Involved in the Disability, and their Condition.—The muscles which are not functioning properly are noted, with special reference to their condition both when the patient is at rest and also when he is attempting voluntary movement. They may be normal, or flaccid, or in spasm (tonic, clonic, or irregular), or they may be simply inco-ordinate. Muscles are good servants, but bad masters. When voluntary control is lost, " the state of a man, like to a little kingdom, suffers then the nature of an insurrection."

The writer is inclined to think that too much attention is focused upon the voluntary contraction and relaxation of the muscles, insufficient emphasis being laid on the fact that when the will is inactive the muscles live a life of their own, influenced chiefly by reflex impulses, but partly also by the composition of the blood which is circulating—it may be very sluggishly—within them. It is impossible to believe that every functional disability has been brought on by suggestion; and the man who persists in a functional disability initiated by organic mischief may be no more of a hysteric or a malingerer than the man who remains deaf for some time in the belief that he is incurable, although, when he is at last persuaded to have medical advice, he recovers his hearing completely as soon as the ears are syringed; it was a mistake, stupid perhaps, but no more.

The Cause of the Condition.—The first problem is diagnosis. How much of the trouble is organic? Is there, or has there ever been, any direct damage to the muscles themselves, to the bones upon which they are designed to act, or to the upper or lower motor neurones by which they should be controlled? Or is it that the tone of the whole muscular system has been so lowered that those muscles which in the course of evolution have been subjected to the greatest strain (as, for example, the peronei, or the abductors of the hip, or the deltoid) can no longer 'carry on'? Or is there indirect organic trouble? Is there a reflex (painful or simply protective) causing spasm, or is œdema hampering the muscles (partly by faulty nutrition and removal of by-products, partly by thickening and stiffening of the limb and of the muscles themselves)? Or have the muscles been so long out of action that their sensory mechanism is out of gear? Is their any alteration in the equilibrium of the body, such as a short limb causing pelvic drop and scoliosis, or on the other hand an injury causing scoliosis followed by pelvic uptilt and an apparent shortening of the limb? Is there a loss of the normal muscular antagonism, through a direct injury of the antagonists or their nerves?

Many cases require several sittings before they can even be diagnosed, and in some the diagnosis can never be certain. Every case should be reviewed from time to time, and frequent consultation between re-educator and surgeon may be necessary, as well as

one or more radiographs or neurological examinations. No case in which there is any doubt—indeed, it might almost be said, no case whatever—should be treated as functional without full examination. The following cases among others show how closely the organic and the functional may be intertwined. Flaccidity of the lower limb has been complicated by synovitis of the knee, rupture of the ligamentum patellæ, incurable stretching of the tendon of the rectus muscle, and Hey's internal derangement of the knee-joint. In one case the pelvis was dropped because of irreparable damage to the abductors of the hip; in another it was uptilted owing to a similar condition of the muscles of the abdominal wall. A flaccidity of the deltoid, diagnosed as obviously functional, was due to a subdeltoid periostitis. Imperfect closure of the fingers sometimes depends upon an organic injury to one or more phalanges or joints of a single finger, especially the medius. In one case a functional flaccidity of the whole upper limb was complicated during treatment by the development of an organic paralysis of the musculocutaneous nerve due to constriction by scar tissue along the track of a foreign body. Finally, in one of the surgical wards, a man who limped slightly, though he declared that he had never been wounded, was found to be suffering from Brown-Séquard's paralysis caused by a bullet embedded in the spinal column.

Treatment.—In every case a plain statement of the facts and difficulties is made to the patient. If any part of the disability is incurable, he is frankly told so. The rest of the trouble is explained as being due to muscle habit, and curable; and as far as possible some period is fixed within which he should be quite cured, whether it be one lesson, one day, one week, or one or more months, due emphasis being laid on the fact that, as in all physical training, a great deal depends upon his own efforts. It is gratifying to note how interested most of these men become in their training, and how it fosters their self-respect. Equally noteworthy has been the enthusiasm of all the trainers who have been working against such odds during the last eighteen months. Diagnosis is the duty of the medical officer, but most of the actual training is carried out by sisters and V.A.D.'s, in whose hands the cases can as a rule be safely left when once the diagnosis has been determined and the form of treatment settled.

Although the methods of treatment vary according to the nature and site of the disability, yet they are all based upon the same principles—namely, stimulating the muscular sense, restoring the reciprocal action of antagonists, and co-ordinating all the muscles under the unerring control of an educated central nervous system. It is impossible here to enumerate the different clinical types and the details of treatment. Notes are, however, appended of a few cases specially selected as illustrating the work of the department from various points of view. Cases could easily have been chosen in which the results might have appeared more striking; and others still more easily which were, or might have appeared to be, failures.

ILLUSTRATIVE CASES.

I. UPPER LIMB.

Case 1.—**Closing of the hand by extension of the first and flexion of the second and third phalanges, following a gunshot wound of the arm.** (*Figs.* 434 *A–E*).

Pte. R. M., age 22, received a gunshot wound in the left arm on Feb. 27, 1917, and was admitted to the 2nd Northern General Hospital on June 21.

RE-EDUCATION DEPARTMENT.

June 22.—Left upper limb is in no way paralyzed. On being told to close the fist, he extends the first phalanges fully and fully flexes the second and third, the whole hand being then kept rigid (*Fig.* 434 *A*). Once the movement has begun, it is not possible to flex the first phalanges passively. The condition is due to immediate over-action of the extensors. On being shown how to keep his hand absolutely relaxed, and then to flex gently the first, the second, and lastly the third phalanges, he carries out the movement perfectly, though very slowly. The two conditions of the hand can be reproduced at will by strong and sudden, or on the other hand by slow and gentle, contraction.

June 29.—Improving slightly.

July 6.—Can flex correctly much more rapidly than before, but very sudden flexion reproduces the disability. Grip exercises.

July 13.—Improving.
July 18.—Greatly improved. He can close his fist more rapidly than even last week. Also, even when he does it very rapidly, and therefore incorrectly, the carpo-metacarpal joints are much more flexed than before.
July 30.—Almost right.
Aug. 1.—Cured.

This case, interesting in itself, is to the writer particularly so, since it was the very first which he cured. The faulty closure was apparently a simple muscular inco-ordination. There was no paralysis, and so long as the hand was at rest, there was no spasm. When, however, patient attempted to close the hand, which he always did with considerable vigour, the interossei did not act strongly enough to flex the first phalanges, so that when the sublimis and profundus flexed the second and third phalanges, their forcible contraction, in the absence of the flexion of the first, brought into play the strong counter-pull of the extensors which is normally seen under corresponding conditions. The flexors pulled harder and harder, but this was countered by the extensors, and as each group called in more and more muscles to assist it, the whole limb at last became rigid, even the trunk being bent over to that side in the desperate attempt to close the hand. Treatment consisted (1) in explaining to the patient the mechanism of the disability; (2) in making him relax every muscle of the limb; and (3) in training him in successive flexion—that is to say, to extend his fingers, and then in the gentlest possible manner, and if necessary with the help of passive movement, to flex in succession the first, second, and third phalanges (*Figs.* 434 *B*, *C*, *D*, *E*). In this way the interossei are brought into play from the first, the contraction of the sublimis and profundus is kept within bounds, and the extensors are never unduly stimulated. When once the hand could be perfectly closed in this gentle fashion, daily practice soon increased the speed and power of the flexion. The notes show well the gradual progress of the case. In some cases it will be found that although perfect range of movement is soon recovered, the power of the grip is very slow in returning; and this is often seen with other types of disability of the hand.

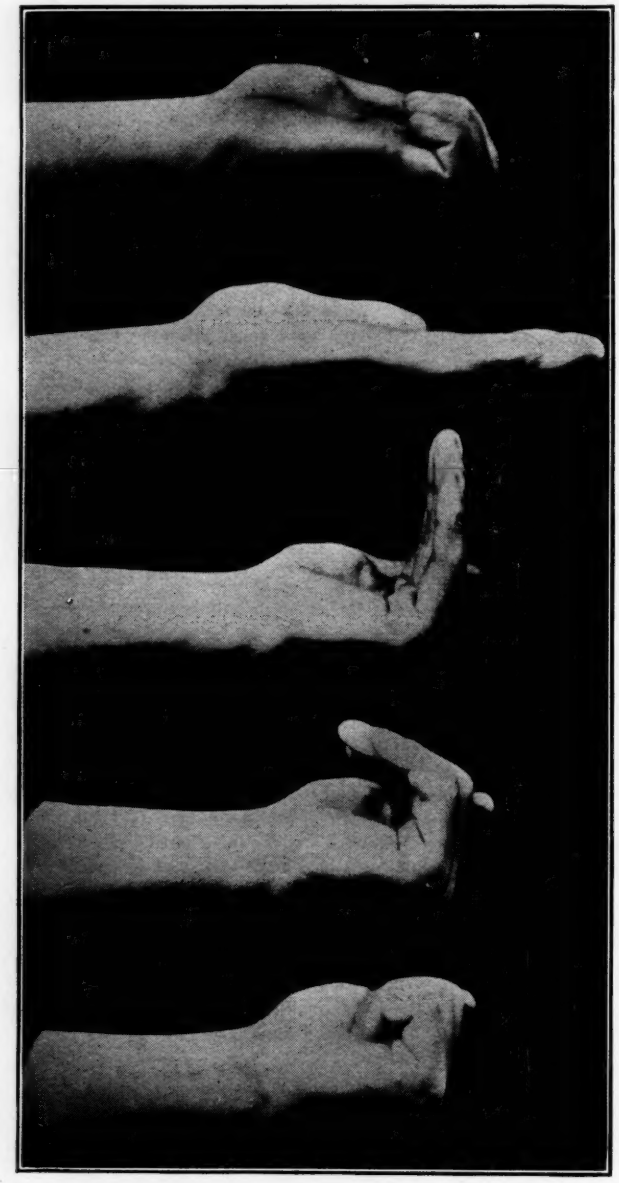


FIG. 434.—(*A*) Closure of the hand by extension of the first and flexion of the second and third phalanges, as in *Cases* 1 and 2.
(*B*), (*C*), (*D*), (*E*), Positions of the hand in successive flexion.

Case 2.—**Closing of the hand by extension of the first and flexion of the second and third phalanges, following a gunshot wound of the shoulder with injury to all the cords of the brachial plexus** (see *Fig.* 434).

Cpl. A. M., age 21, was shot in the shoulder on Sept. 14, 1916, and was admitted to the 2nd Northern General Hospital on July 3, 1917.

SURGICAL WARD.

July 3.—Shrapnel bullets entered below outer half of right clavicle, passed downwards and outwards, and emerged about lower angle of scapula. Upper arm apparently normal. Shoulder normal. Forearm: wasting of flexors. Ulnar palsy in hand.

July 6 (*Nerve Report*).—Severe lesion of all cords of brachial plexus, worst of inner cord. Former anæsthesia now gone. Ulnar distribution only 'numb' now. All muscles respond to faradism except those of posterior cord (which are powerful in voluntary effort).

Sept. 6 (*Nerve Report*).—Little change yet.

Nov. 14 (*Nerve Report*).—All muscles respond to faradism. Slight sensory loss, ulnar area only.

RE-EDUCATION DEPARTMENT.

Dec. 18.—A typical case of disability in closing the hand by extension of the first and flexion of the second and third phalanges. Abduction and adduction of the fingers is not possible. This is to some extent due to the hyperextension of the first with flexion of the second and third phalanges which is the result of the organic lesion and is now probably incurable. With re-education he will rapidly recover considerable range of voluntary movement.

Dec. 20.—Closes his hand perfectly well now. Cannot yet extend his third, fourth, and fifth digits properly. This is due to the hyperextension of the first phalanges and shortening of the extensors causing tension on the long flexor tendons. For this, re-education will do no good.

Dec. 31.—Disability in flexion cured. For the rest, work and time will do as much as any treatment.

This case shows how an inco-ordination may be the result of the orderly recovery of an organic nerve lesion, a result which persists after the lesion itself has recovered, simply because the man does not know that he can be cured, still less that he can cure himself. The bullet injured all the cords of the brachial plexus, and especially the inner cord, so that the nerve-supply to the muscles of the fingers was interfered with, and especially that to the flexors. The order of recovery would thus be—first the extensors, then the long flexors, and lastly the interossei. Now, when a part is disabled, the effort to overcome the disability commonly results in all the muscles of that part, and sometimes those of other parts also, being simultaneously called into action, even although their action is to antagonize one another. When, therefore, in this case the flexors began to recover, the effort to flex brought into play the more powerful extensors; and since these were acting chiefly on the first phalanges, while the interossei were not yet able to extend the second and third, the effort at flexion resulted in a faulty closure of the hand by extension of the first with flexion of the second and third phalanges. When at last the interossei gradually recovered, they had to give way before the long flexors, which were themselves overpowered by the extensors. This inco-ordination was therefore in its onset organic, and it persisted through sheer force of habit, since the man failed to realize that he could close his hand perfectly if only he would set about it in the right way. No doubt he responded to the strong suggestion afforded by the severity of the injury which had originally disabled him; but there is no need to suppose that he was either malingering or hysterical.

Case 3.—**Limitation in flexing the fingers owing to organic disability of the middle finger.** (*Figs.* 435 *A–G.*)

Pte. F. E., age 26, was wounded by a bullet in the left hand on April 13, 1917, and was admitted to the 2nd Northern General Hospital on Oct. 15.

SURGICAL WARD.

Oct. 17.—Compound fracture of left middle finger which is entirely healed. Last phalanx bent to radial side. Finger extended and unable to flex. Other joints of hand movable.

Nov. 16.—Last joint of left middle finger excised to straighten distal phalanx.

RE-EDUCATION DEPARTMENT.

Jan. 4, 1918.—The second and third phalanges are out of court, and the whole finger is useless. Not only so, but this is apparently the cause of the disability of the index, ring, and little fingers. Compare the other hand (*Fig.* 435 *A*). Amputation of the whole medius might restore the use of the rest of the hand.

Jan. 10.—The finger can be fairly well relaxed by patient, and completely flexed by passive movement.

Feb. 28.—The flexor digitorum profundus as a whole is working very badly. Patient is unable to bend the terminal phalanx of any finger well.

March 7.—Would suggest disposal, as no further improvement is noted and no operative measure is wanted by the patient.

FIG. 435 *A*. — The normal hand in *Case* 3. Voluntary extension of the middle finger, with imperfect flexion of the third phalanges of the other fingers. Note the convergence of the index and ring fingers.

FIG. 435 *B*.—Organic stiffness of the middle finger, with imperfect flexion of the terminal phalanges of the other fingers.

In this case there was: (1) A primary organic disability of the middle finger; (2) A secondary organic disability of the other fingers; and (3) A functional flaccidity of the profundus.

FIG. 435*C*.—The same case some months later.

FIG. 435*D*.— Side view of a similar case.

1. The inability to flex the middle finger was organic, being due to the wound.

2. The inability to flex the other fingers (chiefly the terminal phalanges) was also organic, being the inevitable result of the inability to flex the middle finger. At first

sight it might appear that the inability to flex completely the index, ring, and little fingers was due to a purely functional flaccidity of the profundus. A very similar condition was, however, found in the sound hand, in which, if the middle finger was kept either actively or passively extended, the terminal phalanges could not be flexed (*Fig.* 435 *A*) This is quite often seen in normal hands; and if the attempt to flex the fingers be both sudden and vigorous, there may be acute pain at a greater or less distance above the wrist, apparently because the belly of the profundus to the middle finger either contracts and cannot shorten, or else is stretched by the contraction of the bellies to the other fingers. In the case described above, the tips of the index and ring fingers converged; but this, too, is seen in many normal hands, being indeed to some extent found on the sound side in this very case. In certain cases, if the individual fingers be flexed by the sublimis in the order little, ring, middle, and index, each finger will overlap its predecessor, and will only fall into position by sliding down its side.

FIG. 435*E*.— Metacarpo-phalangeal flexion splint.

3. There was also a purely functional flaccidity of the profundus, best seen when the patient tried to flex the third phalanges while the first and second were held in passive extension. The main duty of the profundus is to co-operate with the sublimis in securing complete closure of the hand. Since the muscle could not be used for this purpose, it is scarcely surprising that it should have become flaccid. Unless the organic disability of the middle finger could be eliminated, the whole profundus, even were it cured, would almost certainly relapse ; and in any case the cure would be of little value, since the muscle could only come into play in a movement of no importance. The choice lay between amputation of the middle finger, and division of the tendon of the profundus to the middle finger ; but surgical measures were refused.

There have been other cases with a somewhat similar disability (*Figs.* 435 *B*, *C*, *D*), and one (*Fig.* 435 *F*) in which the other fingers could be fully flexed although the medius remained fully extended. In this last case the joints of the middle finger were perfectly supple, but there was no voluntary power of flexion, nor could the finger be flexed by faradism. As there was a deep scar in the palm at the base of the finger, the flexor tendons had evidently been severed. The other bellies of the profundus would thus be free to flex the terminal phalanges of the other fingers.

Organic stiffness of the metacarpo-phalangeal joint of one or more fingers seriously hampers re-education of the hand. In order to overcome it, the writer has devised the

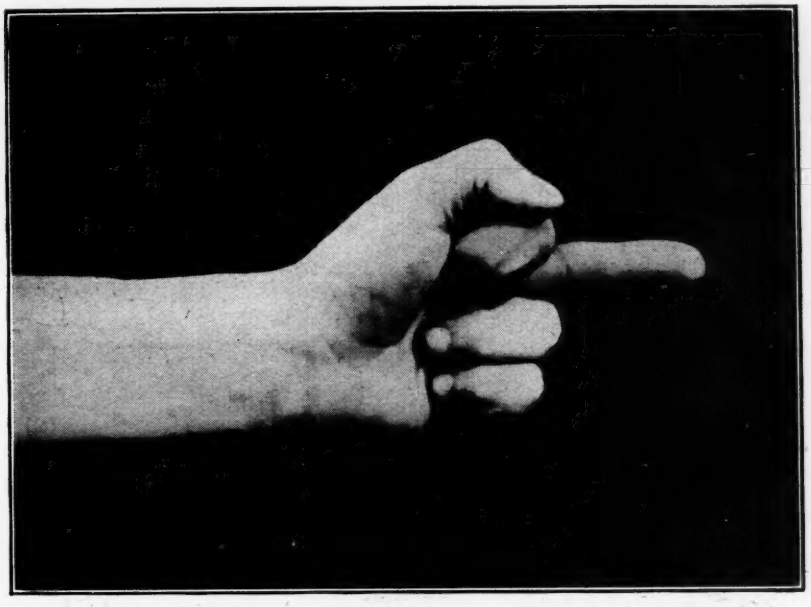


FIG. 435*F*.—Loss of flexion of the middle finger (which is, however, quite supple) with perfect flexion of the third phalanges of the other fingers. The flexor tendons had been severed by a wound at the base of the middle finger, so that the remaining tendons of the profundus were unhampered.

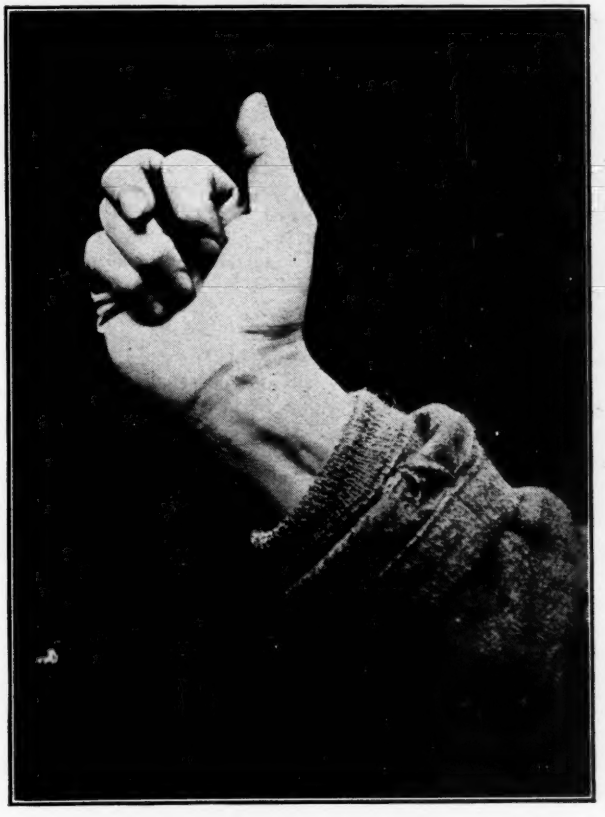


FIG. 435*G*.– Functional lagging of the middle finger, which had been injured about six years previously. Closure of the hand was perfect after one lesson.

splint shown in *Fig.* 435 *E*, which will fit a large or a small limb, whether right or left, and can be applied to one or more fingers, each being dealt with independently so as to secure its maximum flexion.

Case 4.—**Overaction of the flexors in extending the wrist after recovery of a lesion of the musculospiral nerve.**

Pte. F. C., age 32, was referred to the re-education department of the 2nd Northern General Hospital on Sept. 11, 1917, unable to extend the left wrist properly after recovery of a lesion of the musculospiral nerve.

RE-EDUCATION DEPARTMENT.

Sept. 11.—Muscular resistance to extension of wrist. Re-education soon gives good result.

Oct. 9.—Movements apparently perfect, but patient complains of pain on lifting anything heavy.

This case has four points of interest: (1) The preponderance of the flexors is merely the continuance of what was for months an organic inco-ordination. (2) Even when function was restored, patient complained of pain on lifting anything heavy. Pain often vanishes in a surprising way when the part is once more functioning properly; but often

FIG. 436.—Long skeleton cock-up sling-splint (see note to *Case* 5).

it remains, and one must always be careful in diagnosing any pain as purely functional, since the subsequent course of the case often reveals the presence of definite organic trouble. (3) Although this case did well, there are some of this type which are difficult to cure, possibly because the shortening of the muscles has become complicated by fibrous changes. (4) In such a case as this a long skeleton cock-up sling-splint is often useful (*Fig.* 436, and see comment on *Case* 5).

Case 5.—**Over-action of the flexors of the wrist and of the long flexors and extensors of the fingers, with weakness of the interossei, following a gunshot wound of the forearm (*Figs.* 437 *A*, *B*).**

Pte. A. M., was wounded through the left forearm on Oct. 14, 1917. He was admitted to the 2nd Northern General Hospital on April 26, 1918.

Surgical Ward.

Through-and-through bullet wound of middle of left forearm. Hand held in claw position, deviated to ulnar side, and pronated. Considerable atrophy of hypothenar group of muscles. Wrist dropped, spastic contraction of extensors of hand. Very limited power in flexor profundus, practically none in sublimis, very slight power in thenar group, none in intrinsic muscles of hand.

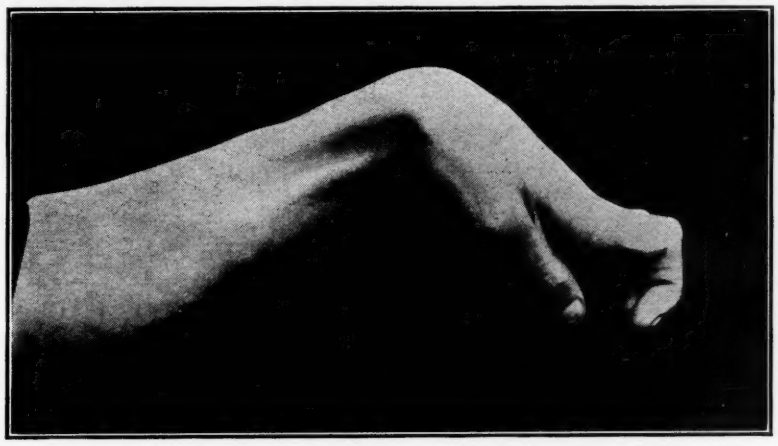


FIG. 437*A*.—Overaction of the flexors of the wrist and of the long flexors and extensors of the fingers, with weakness of the interossei, following a gunshot wound of the forearm (*Case* 5).

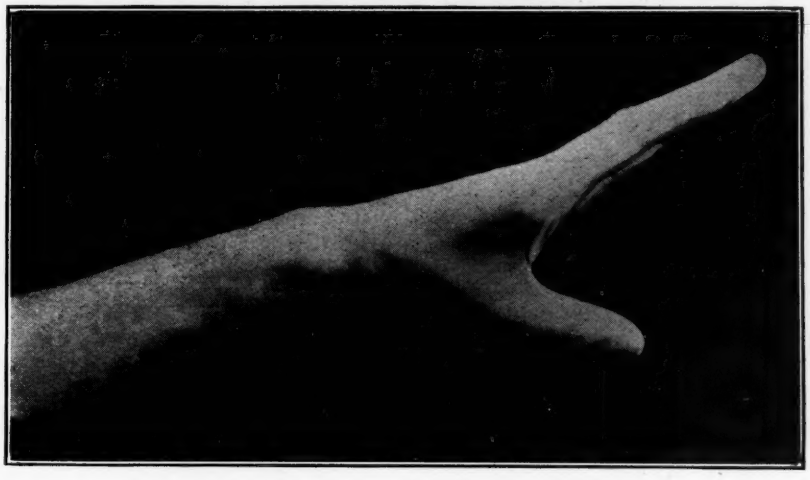


FIG. 437*B*.—The same case after training.

Very slight power of pronation and supination. Blunting of sensation in ulnar, median, and posterior interosseous distribution. Passive movement possible at wrist-joint, no voluntary power.

May 16 (*Nerve Report*).—Mainly if not wholly functional. Spasm passed off to a great extent when the muscles were tired by action.

Re-education Department.

May 24.—Position of rest: Three-quarters pronation, drop-wrist, hyperextension of first phalanges, marked flexion (45°) of second, and slight flexion (0°–10°) of third (*Fig.* 437 *A*). Great rigidity, but absolute relaxation can be obtained.

Aug. 2.—Has never been to the department since May 24. Hand now as it was then. Position of rest the same. Rigidity the same. Relaxation as before.

Sept. 16.—Less muscular spasm.

Oct. 16.—Has now good voluntary movements in every way, though the hand in repose resumes the old position. Time and use should now do as much as further treatment.

This deformity corresponds in some ways to that in the foot known as pes cavus. The extensors and long flexors are in spasm, whereas the interossei are either overpowered or not acting at all. The treatment consisted in absolute relaxation, successive flexion, and the like. The patient was discharged before the muscles had quite resumed the normal co-ordination of rest. Perhaps he ought rather to have been given a long leave, say two months. In the later stages of the cure these cases often do extremely well if sent home for some weeks, especially if they can find any appropriate work. Many a case which is dragging rather wearily to its close is satisfactorily cured in this way, provided the man can be trusted to persevere in training himself at home.

For this and similar cases—especially where, as in *Case* 4, there has been a lesion of the musculospiral nerve—the writer has devised the skeleton sling-splint, one form of which is shown in *Fig.* 436. The hand must not be immobilized, nor yet must it hang down at the patient's side. This splint therefore dispenses with all bandages, and acts as a sling for the forearm, while at the same time the wrist is kept extended by gravity. If the cross-straps are undone, the limb can be freely used ; and yet whenever it comes to rest, the proper position is ensured. When the metacarpo-phalangeal joints should be allowed to flex, a short skeleton sling-splint should be used. The metal band which runs half-way up to the left shoulder stabilizes the splint.

Case 6.—**Over-action of the extensors and flexors of the wrist and of the extensors and long flexors of the fingers, with weakness of the interossei, following a lesion of the ulnar nerve** (*Figs.* 438 *A*, *B*).

Pte. F. B., age 26, was wounded in the left wrist on Sept. 16, 1916, and admitted to the 2nd Northern General Hospital on April 26, 1918.

SURGICAL WARD.

April 26.—Through-and-through bullet wound of wrist. Wound of entrance just below styloid process of ulna, dorsum of wrist ; exit at lower end of ulna, palmar surface. Hand held in claw position, contraction of extensors. Can be passively extended ; voluntary power practically nil. Atrophy of muscles of dorsum of hand. No voluntary movements of fingers or thumb. Considerable blunting of sensation in ulnar and median areas.

June 3 (*Nerve Report*).—Partial ulnar lesion, and very slight sensory loss in median area. Ulnar muscles of hand are powerless, but react to faradism, with exception of outer interossei. Median muscles have power, and react to faradism. Ulnar sensory loss incomplete ; no deep loss. Considerable contraction of extensor group.

July 10 (*Nerve Report*).—Improvement in ulnar lesion. Less absolute sensory loss. Contracted extensors cause most disability, and the trouble is largely functional.

RE-EDUCATION DEPARTMENT.

July 12 —Some organic rigidity of the wrist. On waiting list.

July 25.—Does surgeon think the extensor tendons should be lengthened ?

Aug. 12.—Tenotomy of extensor tendon to middle finger.

Sept. 20.—The condition resembles pes cavus, but the wrist is organically stiff, so that it cannot be much flexed. The spasm of the extensors and flexors may be a reflex irritative condition. Should like to try re-education for one month if surgeon approves. Tenotomy has done no good.

Oct. 5.—Not a great deal of spasm now in the long extensors of the fingers, and very little in the sublimis and profundus. Should be inclined to recommend freeing ulnar nerve from scar above wrist in the hope of helping the action of the interossei.

Oct. 16 (*Nerve Report*).—The slight organic lesion of the ulnar may be at the bottom of the functional disturbance ; careful neurolysis might help.

SURGICAL WARD.

Oct. 21 (*Surgeon's Report*).—Operation, ether. Ulnar nerve exposed at wrist. Considerable scar tissue. A small bulb of nerve, which was not very hard. Nerve freed from scar tissue.

RE-EDUCATION DEPARTMENT.

Nov. 23.—In hand again. No change.

Nov. 30.—Interossei still respond badly to faradism.

Dec. 14.—Improving.

Jan. 4, 1919.—Much improved.

Jan. 23.—Wrist : Voluntary extension full, also flexion until organically limited. Fingers : With wrist extended, index and medius can be fully extended, ring not quite, little finger less ; with wrist in axis, ditto. Action of interossei : Index and medius flexed 90°—0°—0°, ring and little finger, 45°—90°—45°. This condition had a very definite organic basis. The interference with the ulnar nerve is now passing off. Should recommend two months' leave.

How much of this disability was organic, and how much functional? There can be little doubt that there was a distinct lesion of the ulnar nerve, upon which the non-organic was superimposed. In *Fig.* 438 *B* it will be seen that the interossei and lumbricales of the fourth and fifth fingers are not fully extending the second and third phalanges.

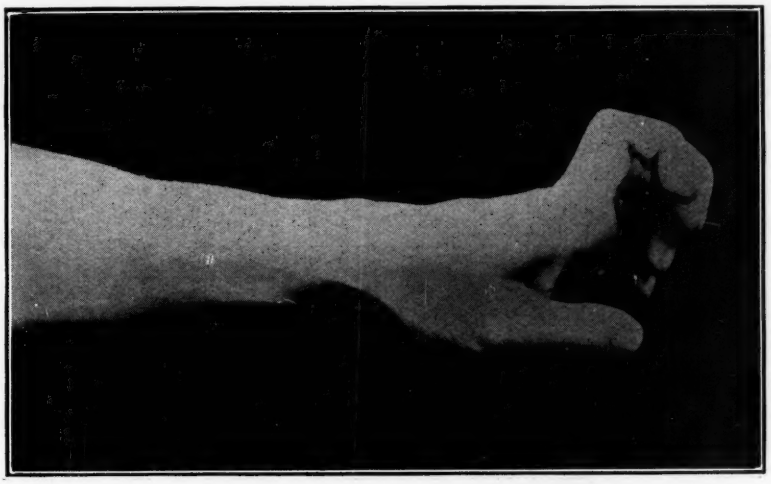


FIG. 438*A*.— Overaction of the extensors and flexors of the wrist and of the extensors and long flexors of the fingers, with weakness of the interossei, following a lesion of the ulnar nerve (*Case* 6).

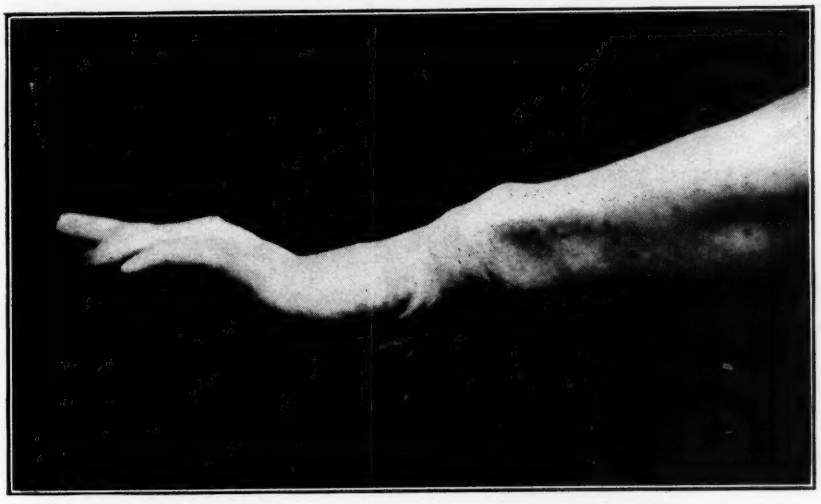


FIG. 438*B*.—The same case after training. Note the position of the ring and little fingers.

Case 7.—**Reflex spasm of the flexors of the wrist, interossei, and adductor of the thumb after a gunshot wound of the forearm** (*Figs.* 439 *A*, *B*).

Pte. J. C., was wounded in the left forearm on June 28, 1918, with fracture of the ulna, and on Aug. 20 was admitted to the 2nd Northern General Hospital.

SURGICAL WARD.

Aug. 20.—Wound through inner margin of left forearm about the middle. Wrist flexed 45°; cannot be extended. Fingers straight, thumb adducted. Marked functional element. Fracture of ulna united. Elbow normal. No voluntary movement in hand.

RE-EDUCATION DEPARTMENT.

Aug. 24.—Spasm of adductor pollicis and interossei. Rigid inco-ordination of whole limb (not much of shoulder and elbow).

Sept. 18 (*Nerve Report*).—Possibly a slight ulnar lesion, as there is a little hypo-æsthesia on fifth digit, but all muscles, median and ulnar, react to faradism. The physiopathic element is the chief factor in causing the disability.

Oct. 14.—Spasm not so marked.

Oct. 21.—For two months' leave, as curative measure.

Jan. 4, 1919.—Greatly improved. No flexor or adductor spasm of any kind, but extensors have not yet fully recovered their tone. Should soon be well.

Jan. 18.—All movements now good. Full extension of fingers and wrist simultaneously.

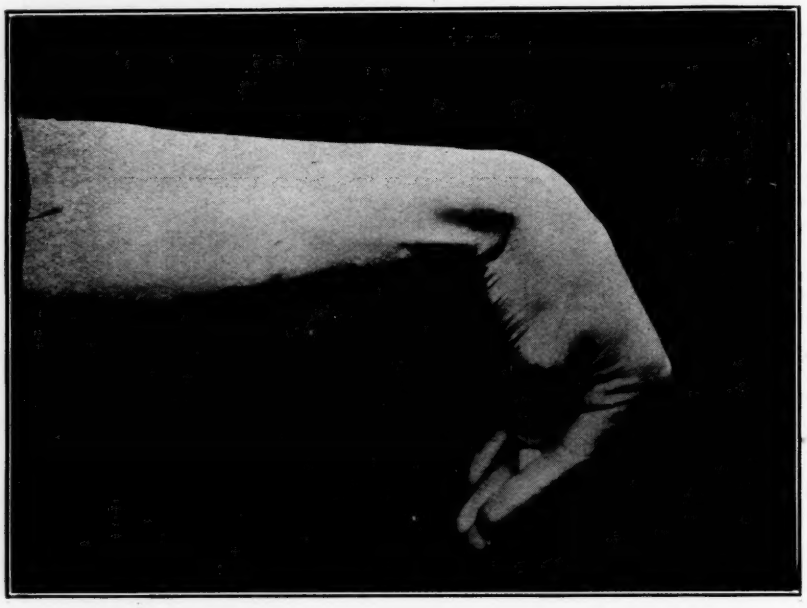


FIG. 439*A*.—Reflex spasm of the flexors of the wrist, interossei, and adductor of the thumb, after a gunshot wound of the forearm (*Case* 7).

FIG. 439*B*.—The same case after training.

There are two points of interest in this case: (1) The condition was a reflex spasm (Babinski's 'physiopathic'—compare *Case* 16); (2) When once the patient knew the treatment, and was found to be working well at it, he was given two months' leave, at the end of which he was almost well.

Case 8.—**Flaccidity in flexion of the fingers and in flexion and extension of the thumb after compound fracture of the radius and injury to the flexor pollicis longus.**

Major J. C. P., age 35, was wounded in the right forearm and left leg on Nov. 10, 1917, and was admitted to the 2nd Northern General Hospital on Feb. 3, 1918, suffering from a disability of the hand.

SURGICAL WARD.

Was hit on wrist by a piece of high-explosive shell, and sustained a compound fracture of the radius.

Feb. 5 (*X-ray Report*).—Union has taken place to some extent. One or two small sequestra present.

RE-EDUCATION DEPARTMENT.

Feb. 13.—Large gunshot wound involving the right radius above the wrist. *X*-rayed. Radial anæsthesia. Pronation and supination: Can pronate almost fully, but supinate only half way; passive pronation and supination: each about three-quarters. Wrist: Movements good. Thumb: Flexion almost nil, although flexor pollicis longus can be felt contracting well in forearm; all extensors act slightly, but without much result, for want of counter-tension; opposition good. Fingers: Extension good; flexion very fair, but incomplete because of organic stiffness; abduction and adduction excellent.

Feb. 22.—Fingers: Flexion much better. Thumb: Extension powerful; flexion of first phalanx good, opposition good. Hand is therefore now about as useful as it can be in the presence of the organic injury to bone and to flexor pollicis longus.

March 5.—Transferred to surgeon.

The disability in flexion of the second phalanx of the thumb was due to the organic injury to the flexor pollicis longus. The inability to extend the thumb or to flex its first phalanx was probably originally due to the shock of the wound, and it was kept up by the persistent extension of the thumb, and by the loss of counter-tension in the flexor, as well as by disuse through the mistaken idea that the whole trouble was organic (as the patient himself freely admitted). The inability to flex the fingers was doubtless begun by the shock, kept up by splinting, and ultimately complicated by the organic stiffness.

The treatment consisted in explaining how the disability arose, and then in combined passive movement and voluntary effort along the lines previously indicated. In this, as in so many cases, the duty of re-education was to banish the non-organic trouble, after which the patient could be handed over to the surgeon for possible further treatment. This patient was neither malingering nor a hysteric. Babinski objected to the term 'hysteria,' and sought to replace it by 'pithiatism,' which he applied to any condition which could be produced by suggestion, and cured by the same means. This would, however, include most of the habits in life, good, bad, and indifferent; thus, there must be few who have ever begun or given up the habit of tobacco-smoking except under the influence of suggestion. Some would retain the term hysteria, but limit it to symptoms produced by suggestion, and similarly curable; but this only transfers the difficulty to the term 'symptoms.' Many disabilities which are still labelled hysterical are simply muscle habits, which have been acquired and retained in quite as rational a manner as some of the everyday habits of modern civilization. The really serious difficulty, however, is the unpleasant suggestion of the effete term 'hysteria.' The time will never come when patients will tamely submit to be called hysterical simply because their medical adviser has learned to water the term down until it has very little solid content.

Case 9.—**Partial flaccidity of the whole upper limb after a gunshot wound of the arm, followed by organic paralysis of the musculocutaneous nerve through constriction by cicatricial tissue.**

Cpl. M. W. B., age 22, was wounded in the right arm and back on Aug. 16, 1917, and was admitted to the 2nd Northern General Hospital on Oct. 17.

SURGICAL WARD.

Oct. 17.—Flesh wounds of right arm and back. Wounds all healed. No operation. Right hand somewhat cyanotic. Abduction of arm limited. Functional?

RE-EDUCATION DEPARTMENT.

Oct. 19.—Wounds of neck and back. Also one on dorsum of arm. Shrapnel still in. Whole limb is feeble. Shoulder: All movements feeble and incomplete—e.g., abduction is very poor. Elbow: Flexion and extension slow, hesitating, and incomplete. Wrist and hand: Complete movements, but feeble. With re-education the movements are less hesitating, stronger, and more complete.

Oct. 23.—In some ways the case suggests an organic lesion.

Oct. 27 (*Nerve Report*).—All muscles of every group give good faradic response.

Oct. 28.—Absolutely no voluntary response in biceps. Ordered simultaneous faradism for all muscles of the arm (musculospiral and musculocutaneous nerves).

Nov. 5.—Hand is improving.

Nov. 9.—Forearm and hand and triceps improving.

Nov. 20 (*Nerve Report*).—Biceps and brachialis anticus show an organic nerve lesion.

Dec. 15.—The limb is now very much improved. The movements of shoulder, wrist, and hand are excellent, but the elbow is still weakened in flexion by the loss of power in the biceps.

Dec. 17 (*Nerve Report*).—Biceps gives a little faradic response now. No sensory loss.

Dec. 22.—Biceps shows no voluntary response yet. Ordered a caliper splint which allows extension to 90°.

Jan. 12.—Now has splint. As this is an organic lesion of the biceps, it would be enough if patient turns up in the re-education department once a month for supervision.

Feb. 27.—Biceps now shows voluntary response. *X* rays show foreign body (? shrapnel) interfering with the musculocutaneous nerve.

March 9.—Operation for removal of foreign body decided on.

March 11.—Operation, ether. Foreign body found between internal and lesser internal cutaneous nerves and removed. There were adhesions around musculocutaneous nerve. These were freed, and vaseline was smeared on.

This case is curious in that, while the purely functional flaccidity was being rapidly cured, an organic nerve paralysis developed through constriction by cicatricial tissue, and then gradually cleared up of itself, the foreign body being finally removed in order to prevent further trouble.

Case 10.—**Almost complete flaccidity of the whole upper limb following a severe wound of the shoulder.**

Pensr. W. R., age 22, was wounded in the right shoulder on July 2, 1916, and discharged from the service. He was admitted to the 2nd Northern General Hospital on Sept. 17, 1917.

Re-education Department.

Sept. 17.—*Previous History*: On July 2, 1916, was hit by shrapnel in region of right shoulder. At once lost use of his whole right upper limb, and has never since been able to use it in any way, except that there was a slight range of movement in flexion and extension of the fingers.

Present Condition: (1) Large scar with centre about 1¾ in. below middle of clavicle; shrapnel which caused the wound was removed by same route. (2) Deep round scar in front of shoulder about 2 in. below acromion; shrapnel entered here and passed backwards and inwards. (3) Large scar in outer part of infraspinous fossa; says shrapnel of scar (2) was taken out or came out here. (4) Scar 2 in. by 1 in. lying longitudinally along groove on outer side of biceps, with centre about 5 in. above elbow; says this was an incision for suppuration. There is no obvious reason why the wound should have given rise to the disability if it is due to organic lesion of the nerves. The nerves were examined at the 5th Southern General Hospital, and were stated to be 'all right.' Scars have been healed a long time, except the one in front of shoulder, which has been healed only three weeks. The limb hangs limp by the side. No active movements, except that there is very slight flexion and extension of the fingers. The phalanges are all slightly flexed, so that the terminal phalanges lie in a plane at right angles to that of hand. The range of movement of the tips of the fingers is only about an inch.

Sept. 20.—Is showing slight signs of improvement in fingers.

Sept. 24.—Improving. All the joints have fortunately remained supple, and as he is anxious to get well, he should improve rapidly.

Sept. 27.—Can abduct arm slightly, flex elbow slowly for some distance, flex and extend wrist to some extent, and flex and extend and abduct and adduct fingers slowly but almost perfectly as far as range is concerned.

Oct. 6.—Improving well.

Oct. 15.—Still better.

Oct. 25.—Can do almost everything but raise shoulder above horizontal. Because of weakness of humerus it is undesirable to try for much more. The *x*-ray photograph shows (1) an oblique fracture of the shaft of the bone about the level of the surgical neck, and (2) a rounded notch involving about half the diameter of the shaft, evidently marking the point at which the projectile had forced its way through the bone.

Nov. 1.—Cured.

This case, rightly or wrongly, suggested to the writer that a 'muscular anæsthesia of disuse' may sometimes be responsible for the persistence of flaccidity. In the monkey, section of all the posterior (sensory) nerve roots to a limb results in motor paralysis. Is it not possible that something like this may take place in a wounded limb which

first suffers a severe shock and then is kept quiet for a long time by means of splints, and also by the patient's ignoring all reflex stimuli, and suppressing all voluntary impulses. Because the muscles do not contract, the sensory nerve-endings within them and their tendons are never stimulated. The muscles are in fact in a condition resembling sleep. When finally the splints are taken off, and the limbs may once more be moved, the muscles can only be made to contract by order of the higher centres. But, for their knowledge and control of the muscles, the centres depend upon the sensory nerve-endings themselves, and these remain quiescent until the tension within the muscles is varied by their contraction. The muscles must therefore be waked by both passive and voluntary stimuli. The first contractions are chiefly due to the direct and reflex stimuli of the passive movements, but the will gradually gains more and more control.

Case 11.—**Limitation in abduction of shoulder (through spasm) after a fall. Aphonia.**

Pte. J. L. was admitted to the 2nd Northern General Hospital on Nov. 28, 1918.

SURGICAL WARD.

Nov. 28.—Accidental fall during physical training. Now soft crepitus felt over superior angle of scapula. Shoulder held stiff by muscular spasm. No bone injury.

RE-EDUCATION DEPARTMENT.

Dec. 7.—Voluntary abduction of shoulder to 50°, passive to 85°. Spasm of pectoralis major and teres major. Crepitus above spine of scapula. Scar of incision beside upper angle of scapula.

Dec. 14.—Voluntary abduction to 80°.

Jan. 2, 1919.—Now good action of the deltoid, but rotation of the scapula is very poor. None of the muscles of the shoulder are working well, except perhaps the upper part of the trapezius.

Jan. 14.—Has had a cold. Aphonia for a week. Still speaks in a whisper. Throat rather sore. Not using abdominal muscles at all. With training, he recovered his voice in forty-five minutes.

Jan. 15.—Pain in back, right and left scapular regions. Rheumatism ?

March 12.—Abduction of shoulder to vertical. Cured ?

In this case there is undoubtedly an organic cause of the crepitus, which is situated apparently in the interval between the muscles of the limb and those belonging to the trunk. This type of crepitus has been observed in several cases. It may possibly be due to a 'rheumatic' fibrositis. It sometimes follows fracture of the scapula, and in this very case the scapula had been explored for fracture in the region of its upper angle. The aphonia is the first case on record in the department. In civil practice the writer has always relied upon the application of lactic acid to the vocal cords, a method which is usually successful in a few minutes. In this case, however, it was decided to apply the general principles upon which the whole work of the department is based. The aphonia was due, not to inability to approximate the cords or to use the muscles of the mouth, thorax, or abdomen, but to an inco-ordination of these groups. Treatment therefore consisted in training him to use each group in the proper way at the proper time. It is a question of team work.

Case 12.—**Tonic adduction of the arm complicating ankylosis of the shoulder-joint.**

Pensr. T. R., age 60, had his left humerus dislocated in November, 1915. This remained unreduced, and he was finally admitted to the 2nd Northern General Hospital on Jan. 15, 1919.

SURGICAL WARD.

Jan. 15.—Arm held stiffly at side, but shoulder can be abducted passively through about 18°. Shoulder-girdle muscles, especially deltoid, very much wasted. Biceps and triceps fairly well nourished. Forearm and hand normal. *X-ray Report*: Head of humerus has been partially dislocated upwards, and is now ankylosed to the glenoid cavity.

Jan. 16.—In addition to his scapulo-humeral ankylosis, he holds his scapula firmly fixed by means of his pectorals and teres muscles.

RE-EDUCATION DEPARTMENT.

Jan. 18.—All movements of shoulder extremely limited. With training he can flex to about 60° and abduct to about 70° voluntarily. Severe pain.

Jan. 24.—Voluntary flexion 90° and abduction 80°. The first night after treatment he says he could scarcely sleep for pain. Now he has very little. Can now get his left hand to the back of his neck, for the first time for two years.

Jan. 30.—Cured. Transferred to surgeon.

The non-organic disability was rapidly cured, and then the patient was referred to the

surgeon for possible surgical measures. The patient states that he had done twenty-two years' service, and that he rejoined for this war. During the erection of a bridge a plank fell upon his shoulder. It is possible, therefore, that the acromion was fractured and slightly dislocated downwards. The movement of the arm became more and more limited, until at last it remained fixed at his side.

II. LOWER LIMB.

Case 13.—**Flaccidity of the long extensors of the toes after a wound of the foot causing extensive ankylosis of the tarsus** (*Figs.* 440 *A*, *B*).

A.-B. J. A. R., age 20, was wounded in the right thigh and on the dorsum of the foot on Dec. 27, 1917, and was admitted to the 2nd Northern General Hospital on July 22, 1918.

SURGICAL WARD.

July 22.—Large scar on posterior and inner aspect of lower third of right thigh. Knee has free range of motion. Scar on dorsum of right foot and inner aspect of ankle. Ankle free, full range of motion. Toes and foot rather stiff. No power of dorsiflexion. *X*-rayed.

July 26 (*Nerve Report*).—A degree of power in all these muscles. The dorsiflexors are weakest, probably owing to long inactivity and the septic condition of wounds in the neighbourhood. There is some adhesion of the outer tendons of the extensors of the toes.

Sept. 5 (*Nerve Report*).—Suggest removal of scars and freeing of tendons. The whole case seems to be one of minor damage, progress halting from presence of scar, pain, and adhesion.

RE-EDUCATION DEPARTMENT.

Nov. 21.—Tibialis anticus working well, but little or no voluntary power in extensor digitorum longus, peroneus tertius, and other peronei.

Dec. 3 (*Surgeon's Report*).—Stay in bed until ulcer is healed.

Dec. 12 (*Surgeon's Report*).—Ulcer almost healed.

Jan. 3, 1919.—Ulcer of thigh not yet healed.

Jan. 15.—No inversion or eversion. This appears to be organic. *X*-ray ordered.

Jan. 16 (*X-ray Report*).—Ankylosis of most of the tarsal and all the tarsometatarsal joints.

Jan. 22.—Now has good extension and flexion of ankle and toes, so that he may well be taken over by the surgeon.

A *B*

FIG. 440.—(*A*) Flaccidity of the extensors of the toes after a wound of the foot causing extensive ankylosis (*Case* 15). (*B*) The same case after training.

Fortunately the ankylosis had taken place in good position, so that with good flexion and extension he can walk well. Further training of the evertors would have been useless.

Case 14.—**Partial flaccidity of the foot after a fall into a shell-hole.**

Pensr. S. C., age 37, fell into a shell-hole in February, 1916. He was admitted to the 2nd Northern General Hospital on Dec. 3, 1918, and at once referred to the re-education department.

SURGICAL WARD.

Dec. 3.—Fell into a shell-hole with a motor cycle. Next morning 'no use' in right leg, but he managed to trail himself to a hospital without the aid of a stick. Present condition purely functional. Peronei working, though weakly. Fair dorsiflexion of ankle. He walks badly on the outer side of the foot, with sole inverted.

RE-EDUCATION DEPARTMENT.

Dec. 5.—At first the whole right limb was 'almost useless.' Gradually improved, but now walks very badly on the outer border of the foot. Very slight dorsiflexion of ankle (toes rise about 1 in.). Only slight flicker of toes with long extensor. No voluntary eversion, and almost no inversion, of ankle. With training he rapidly recovers considerable dorsiflexion, eversion, and inversion.

Dec. 12.—Requires light boots.

Dec. 19.—Has proper boots and now walks perfectly. No one could tell which had been the defaulting limb.

This case illustrates a type in which 'excitation' of the foot is sometimes very effective. Hyperextension of the toes to the degree of causing pain rouses the muscles through a painful reflex. The dorsiflexors of the ankle and the extensors of the toes respond at once, and with appropriate passive movement and voluntary effort the peronei soon follow suit. Even then, however, the patient may persist in walking on the outer border of the foot. This is a pure bad habit, and may be seen in cases where from the first every muscle pulls normally except in the act of walking. The treatment consists in explaining the habit, and then in getting the patient first to flex his thigh and leg, while at the same time dorsiflexing and everting the foot ; and then to extend the thigh and leg, keeping the foot dorsiflexed and everted. The patient often inverts the foot before it reaches the ground, in which case he is likely to be rapidly cured. Sometimes, in order to get him to put the weight on the inner border of the foot, it is necessary for him to walk with the thigh abducted and the knee slightly flexed. This gives him a very awkward gait, but it will probably convince him that the foot can be kept everted even when supporting the body-weight. When training begins, care should be taken that patient has a light pair of boots, the soles of which are not unevenly worn down ; and if he wears rubber heels, these must not be round and loose as is so often the case, but they must be heel-shaped and firmly attached all over.

Case 15.—**Tonic inversion of the foot in walking, and flaccidity of the peronei, owing to a painful scar on the sole.**

Pte. A. C., age 22, was admitted to the 2nd Northern General Hospital on Nov. 27, 1917, with a painful scar on the left sole and disability in walking.

SURGICAL WARD.

Nov. 27.—Healed wounds of left thigh and leg. Healed wound of sole of foot. Foot is spasmodically contracted in inversion, so that he walks on its outer side. Calf muscles contracted.

Dec. 11 (*Nerve Report*).—This is a case of reflex inco-ordination due to local causes. There is no organic injury to the nervous system, higher or lower.

RE-EDUCATION DEPARTMENT.

Dec. 15.—As he lies in bed, there is good dorsal and plantar flexion of ankle, but peronei are not working very well. He walks on outer border of foot, to save a tender scar on inner side of sole.

Jan. 5, 1918.—The peronei are now working, so that the whole foot is normal in its muscular apparatus. There is no spasm, flaccidity, or clonus as he sits or lies with the foot at rest. On walking, the foot is markedly inverted, but this is purely to save pain in the scar. Re-education is no longer required.

In this case pain was responsible for the production and continuance of the disability. The deliberate suppression and neglect of the peronei resulted in complete loss of control, so that even when lying on a couch he could not evert the foot. Unless the painful scar was removed, relapse was certain.

Case 16.—**Tonic inversion of the foot, with œdema of the foot and leg, after gunshot wounds of the leg.** (*Figs.* 441 *A*, *B*.)

L.-Cpl. G. M. was wounded in the left leg on Nov. 20, 1917, and admitted to the 2nd Northern General Hospital on June 13, 1918.

SURGICAL WARD.

June 13.—*Previous History:* Gunshot wound of left leg, no fracture, on Nov. 20, 1917. Foot has been swollen and painful. No operations. Still foreign body in leg. Wounds healed about February, 1918. Foot was put into plaster case for twisted condition. Removed after three weeks, but no good effect. *Present Condition:* Foot now inverted, swollen, and very painful. All four small toes drawn down by flexors. Tendo Achillis much contracted.

RE-EDUCATION DEPARTMENT.

Aug. 26.—Foot can be passively everted with much effort. Great œdema of dorsum of foot and even of whole leg up to the knee. Blue and cold.

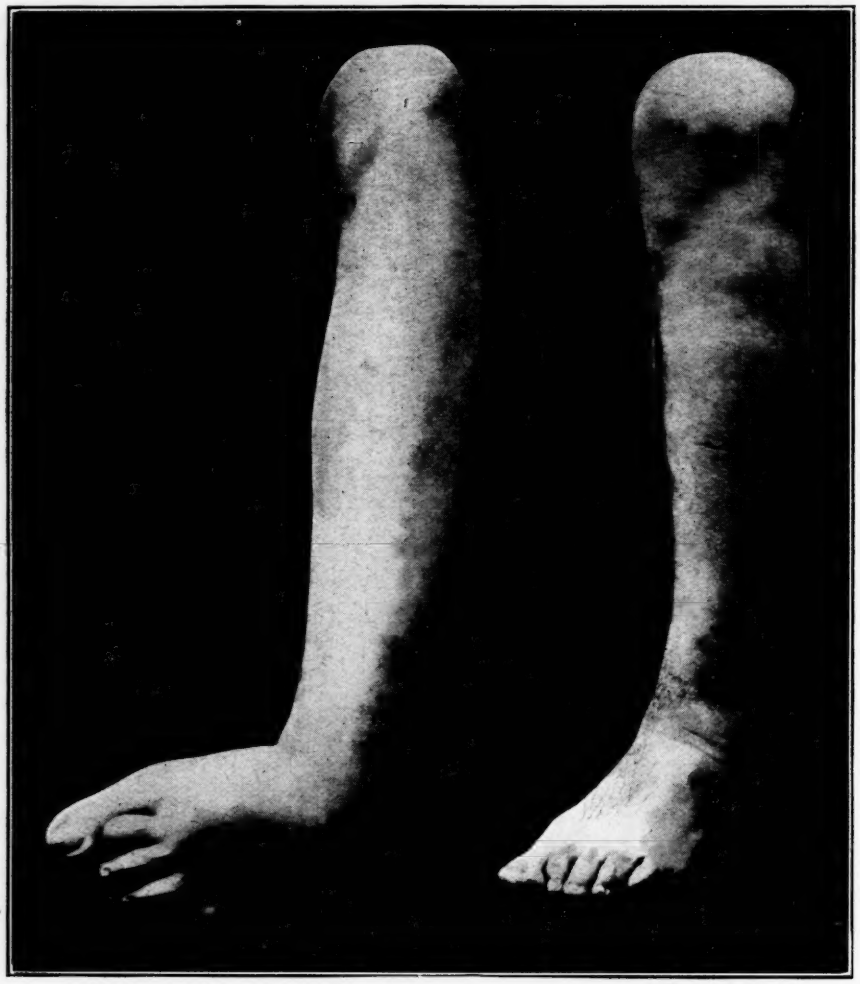
Oct. 28.—Colour better. Swelling much less, and not nearly as much spasm. Slight voluntary power in toes and ankle muscles.

Nov. 18.—Much more relaxed. Gaining voluntary power in extensor longus hallucis, and slightly (?) in extensor longus digitorum. Spastic flexors relaxing. Swelling less and colour improved.

Nov. 30.—Œdema almost gone. Foot good colour, and considerable voluntary power—e.g., he can bring the foot into fair position—but the tendo Achillis and its muscles are still too tight. Can now wear a boot with eversion chain.

Dec. 17.—Gradually improving.

Jan. 10, 1919.—Should soon be able to leave hospital.



A *B*

FIG. 441.—(*A*) Tonic inversion of the foot, with œdema of the foot and leg, after gunshot wounds of the leg (*Case* 16). (*B*) The same case after training.

This type of case Babinski has termed 'physiopathic,' and he has detailed numerous signs by which such cases may be distinguished from purely functional ones—as, for example,

vasomotor disturbance. increased irritability of the muscles to direct mechanical stimulation, prolonged contraction, and so on. Although Babinski thinks ultimate recovery likely, he does not appear to consider treatment of much value. There is no doubt, however, that, whatever may be their origin, these cases sometimes respond to treatment very well. At the 2nd Northern General Hospital, little difference is made in their treatment, although dried extract of thyroid (? parathyroid) gland has sometimes seemed to be of value.

FIG. 442.—(*A*) Eversion chain, crossed, with spring. (*B*) Eversion chain, uncrossed. The chain passes through the spring, and in this figure it is taut.

In all forms of drop-foot, and more particularly in those due to a nerve lesion or where there is tonic inversion, it is desirable to evert the foot well. This can only be done by a pull acting in front of the mid-tarsal articulation. For this purpose the writer has added to the apparatus in general use in the hospital an eversion chain, which may be described as 'arising from' an upright on either the inner or the outer side of the leg, and being ' inserted into ' a metal attachment on the boot opposite the base of the fifth metatarsal (*Fig.* 442 *A*, *B*). In some cases the chain acts better from an outer upright, and sometimes better still when the 'origin' is at the level of the upper border of the boot. A spring is often useful, and if the chain be passed through it and so attached to it as to leave two or three links relaxed within the spring, then, when the spring has yielded to its proper length, the chain becomes taut and prevents overstretching.

Case 17.—**Flaccidity of the foot and pelvic drop after a gunshot wound of the ankle.**

Pte. W. S. was admitted to the 2nd Northern General Hospital on July 30, 1918, with a healed gunshot wound of the left ankle-joint and drop-foot.

SURGICAL WARD.

Aug. 1.—Scar on lower half of left leg posteriorly—the point of entrance of the bullet. Scar on dorsum of foot and front of ankle, from operation. Healed about one month. Foot is dropped, with no power of dorsiflexion.

Aug. 13 (*Nerve Report*).—No nerve injury. All muscles will work with persuasion.

RE-EDUCATION DEPARTMENT.

Aug. 29.—No muscles pull to-day.

Sept. 6.—All muscles contract in ankle and foot.

Oct. 4.—Extensor hallucis pulling better.

Nov. 14.—All muscles pulling well, and movements of foot quite good. Still complains of pain in ankle, which makes him limp, and there is still pelvic drop to the right.

Nov. 23.—Pelvic drop has improved, but very difficult to treat, because he cannot put full weight on the foot.

Nov. 29.—Pain rather better.

Dec. 3.—Very little pain. This comes on after he has been resting the limb, and passes off with exercise. Now almost well. Should recommend two months' leave.

The pain in the foot interfered with and prolonged the treatment. There is no valid reason for supposing that it was purely functional.

In the treatment of pelvic drop when drop-foot is present, an eversion chain is a great help, since it stabilizes the foot (see *Fig.* 442).

Case 18.—**Limitation in flexion of the knee after a gunshot wound of the hamstrings.**

Bombr. H. P. was admitted to the 2nd Northern General Hospital on Oct. 10, 1918, with a severe wound of the back of the right thigh.

SURGICAL WARD.

Oct. 10.—Cicatrix along posterior aspect of right thigh. Small discharging ulcer in centre. Large amount of scar tissue. Marked twitching of thigh muscles. Marked tenderness in region of scar. Not able to extend leg beyond 125°. Slight power in extension and flexion of toes. Drop-foot splint.

Oct. 17.—Thomas's knee caliper. Right sole and heel to be raised one inch.

Oct. 26.—Minor lesion of external popliteal branch of sciatic nerve. All muscles are working, and are in a good state of nutrition.

Nov. 29.—Acute tenderness over scar.

RE-EDUCATION DEPARTMENT.

Dec. 13.—Condition appears to be non-organic. If so, he should do well. At the same time there is considerable loss of muscle tissue. The Thomas splint and thick sole and heel should be removed. Later: After an hour's treatment, he is at times able to straighten the knee voluntarily, and he walks much better. Massage to be stopped.

Dec. 16.—Doing well. To have light boots.

Jan. 6, 1919.—Walks with knee straight, but there is tension on the scar, and it keeps breaking down in the centre.

Jan. 10.—Would surgeon consider plastic operation?

There was pain on movement, and much loss of muscle tissue, and tension on the scar both superficial and deep. This made it difficult for him to recover full extension of the knee, and equally difficult to retain it, an exceptionally strong effort of the will being required both to contract the quadriceps and to relax the hamstrings. In such a case the tension should as far as possible be relieved by surgery, to reduce this effort to the normal.

Case 19.—**Limitation in flexion of the knee and pelvic drop, after a gunshot wound of the leg.**

Cpl. P. S. was wounded through the right leg on Aug. 11, 1917, and was admitted to the 2nd Northern General Hospital on April 9, 1918.

SURGICAL WARD.

Incomplete extension of knee (to within 30° of straight), and dorsiflexion of ankle. Foot is weak. Walks slowly with a limp. Small scar over calf.

April 16.—Scar stretched without much difficulty under ether. Knee put into extension, foot in dorsiflexion.

RE-EDUCATION DEPARTMENT.

May 25.—Slight limitation in flexion of knee. No disability of foot. Marked drop of pelvis on the left. When this is cured, gait will be normal. He now walks on his toes, but with special pelvic exercises he does well.

May 28.—Now scarcely a limp.

In this case the shock of the original wound probably caused a flaccidity of the right limb, which persisted in the abductors of the hip, and so led to a pelvic drop on the left side, the apparent increase of length in the left limb being compensated by walking on the right toes, which was all the more necessary when the knee was flexed. The pelvis is treated as follows. By means of a model the mechanism of the disability is explained to the patient, and then by alternate elevation of the hips and by simultaneous abduction and adduction of the limbs to right and left alternately, he is shown that either limb can be made to appear the longer or the shorter, according to their position in relation to the pelvis. He is then trained (1) on his back : (*a*) to elevate the hips alternately, with the lower limbs fully extended ; (*b*) to flex the lower limbs alternately (hip, knee, and ankle) ; (*c*) to combine the two previous exercises. He now (2) stands up, and is trained : (*a*) to 'mark time,' with full elevation of the hips and flexion of the hips, knees, and ankles ; (*b*) to continue the previous exercise, but stepping out a little and gradually moderating the elevation and flexion ; (*c*) to alight on the heel, advance on the sole, and step off from the toes. In a few cases a single lesson cures the bad habit ; but usually some after-training is required, while a few cases show little response.

Case 20.— **Flaccidity of the quadriceps and pelvic drop after a gunshot wound of the knee with rupture of the infrapatellar ligament.**

Pte. C. P., age 30, was wounded on March 28, 1918, and admitted to the 2nd Northern General Hospital on July 26.

SURGICAL WARD.

July 26.—Left knee shows healed scar just below patella and over infrapatellar ligament. Scar is very painful. No power in quadriceps. Whole leg must be supported. Slightest passive movement of knee-joint is painful. On palpation, the only painful spot is the scar.

Aug. 15.—Operation, ether. Infrapatellar ligament found torn away from its insertion. Freed and sutured.

Sept. 10.—Foot can be raised from the bed. Up and about on crutches.

Sept. 24.—Knee can be flexed to right angle.

Oct. 15.—Cannot extend leg yet.

RE-EDUCATION DEPARTMENT.

Oct. 24.—Quadriceps is the cause of the disability now. Little or no voluntary contraction. Full range of passive movement without pain. Walks without knee flexion, and uses two sticks.

Nov. 15.—Quadriceps has now distinct power, but functions poorly. Patient still requires two sticks. With training he can extend the knee much better. Has quite a fair kick, and he can walk a little way without support.

Nov. 19.—Improved.

Nov. 29.—Slight drop of pelvis on the right.

Jan. 8, 1919.—Limp almost imperceptible.

In such a case as this, treatment of the functional disability must be postponed until the surgeon has remedied the organic defect. It is often very difficult to decide whether the disability is organic or functional, or mixed ; and, if mixed, what the first treatment should be, surgery or re-education.

Case 21.—**Flaccidity of the quadriceps and pelvic drop after gunshot wounds of the thigh.**

Pte. C. I. was admitted to the 2nd Northern General Hospital on Oct. 22, 1918, walking on crutches.

SURGICAL WARD.

Oct. 25.—Two scars on left thigh. Whole limb wasted. Considerable limp, with pain referred to front of patellar attachment.

RE-EDUCATION DEPARTMENT.

Oct. 26.—Pain just above patella on movement of knee. All muscles of limb and foot acting, but quadriceps quite feeble at all times. In walking, patient limps badly, using right limb almost entirely to carry body-weight, and keeping left knee partly flexed. Non-organic weakness of quadriceps seems entire cause of disability.

Nov. 1.—To have light boots.

Nov. 8.—Gait improved.

Nov. 14.—Ung. methyl salicyl. for left knee. Exercises for right pelvic drop.

Nov. 21.—Walks without support quite fairly well. Quadriceps excellent.

Nov. 22.—Very marked improvement.

Nov. 29.—Cured.

The pain in this case vanished, and the function of the limb was completely restored. Light boots are usually necessary, and methyl-salicylate ointment is sometimes useful. It might be mentioned here that in one or two cases there has been some difficulty in deciding whether the shortening of the one limb was actual or only apparent. This may be settled by measuring in the usual way the distance on the two sides between the upper border of the great trochanter and the lower border of the internal malleolus. Since abduction of the limb lessens, whereas adduction increases, the distance between the anterior superior spine of the ilium and the internal malleolus, the above test may be confirmed in the following way. If the patient lies down with the limbs placed side-by-side, and if the perpendicular from the midpoint between the spines passes between the feet, then the difference in level of the internal malleoli is the difference in the actual length of the limbs. It is well to bear in mind that organic shortening is shown by a drop of the pelvis on the side of the injured limb, whereas pelvic drop due to flaccidity is usually on the opposite side. Both conditions may of course be present.

Case 22.—**Incomplete flaccidity of the whole lower limb following a bullet wound of the thigh, and complicated by fluid in the knee-joint.**

Pte. C. B. was admitted to the 2nd Northern General Hospital on July 20, 1918.

SURGICAL WARD.

July 20.—Through-and-through bullet wound of right thigh. Some atrophy of thigh and leg muscles. Knee cannot be flexed beyond 100°. Tendency to equinovarus when foot is at rest. Pain extending down anterior aspect of leg. Can evert, invert, and dorsiflex foot quite well.

Sept. 6.—No power of dorsiflexion. Anterior tibial group of muscles acting very sluggishly, if at all.

Sept. 13 (*Nerve Report*).—Not much in the way of nerve injury. All muscles react readily to faradism.

RE-ED CATION DEPARTMENT.

Sept. 21.—Disability of entire limb, but much improved. All muscles act with excitation, but there is some inco-ordination in voluntary movement.

Oct. 5.—Almost no power in ankle and toes. Very little in knee (feeble, hesitating); rather better at hip. A general flaccidity of the right lower limb (incomplete), with left pelvic drop. There is some fluid in knee, and patient complains that knee often gives way in walking.

SURGICAL WARD.

Oct. 11.—Effusion in right knee, limiting flexion.

Oct. 18.—General wasting of quadriceps and extensor structures about knee-joint.

Nov. 8.—No effusion in joint.

RE-EDUCATION DEPARTMENT.

Nov. 16.—Foot is still very flaccid. Some voluntary dorsiflexion. Very little use of extensor longus digitorum and peronei.

Nov. 22.—All muscles of lower limb working well. Good extension of knee, good dorsiflexion and eversion of foot.

Dec. 13.—Quadriceps is still not so well developed as on the left side, but patient has complete control of the limb, and there is no pelvic drop.

The development of the fluid in the knee-joint showed that there was a considerable organic basis for the purely functional trouble, and for a time it made treatment impossible.

Case 24.—**Complete flaccidity of the lower limb accompanying wound of the quadriceps with subsequent overstretching.**

Pte. H. D., age 34, received a gunshot wound of the left knee on April 11, 1917, and he was admitted to the 2nd Northern General Hospital on Nov. 22.

SURGICAL WARD.

Nov. 22.—Small scar over upper part of patella, and small sinus two or three inches above joint on popliteal surface of thigh. Bits of bone are said to come out at times. No interference at joint with flexion or extension. Abnormal lateral mobility and rotation present. No abnormal antero-posterior mobility. No excess of fluid, patella movable, no points of tenderness, slight crepitus on flexion and extension. Apparently no power either to flex or extend the joint. There is a good deal of atrophy of thigh, less of calf; much weakness in flexion and extension of foot. *X*-ray ordered.

Dec. 1.—*X*-ray shows clean perforation.

Dec. 6 (*Nerve Report*).—No area of anæsthesia. All muscles respond to faradism and have voluntary power.

Dec. 14.—Popliteal sinus to be irrigated with eusol daily. Continue back splint to knee. Daily massage of anterior thigh muscles and hip muscles—avoiding region of sinus, and gently over knee—and of whole leg.

Dec. 21.—Sinus practically closed from bottom, and now only a small superficial granulating surface.

Dec. 29 (*Nerve Report*).—All muscles which control knee respond to faradism. They are much atrophied. Faradism of quadriceps ordered.

Jan. 1, 1918.—Wound healed.

RE-EDUCATION DEPARTMENT.

Jan. 18.—Complete disability of left knee. Quadriceps absolutely flaccid. Hamstrings flaccid, but semitendinosus shows some flickering. Cannot keep the leg vertical as he lies on his face. With re-education semitendinosus and biceps work better, and he can keep the leg up (with great difficulty). Quadriceps has been badly stretched.

Jan. 22.—Can keep his leg vertical quite easily when on his face.

Jan. 23.—Can hold leg up even when flexed less than 90°.

Jan. 25.—Can now as he lies on his face easily flex the knee from full extension through the full range. Quadriceps, however, is still absolutely refractory; there is not even a flicker, although tapping on the infrapatellar tendon produces a sharp contraction.

Feb. 10.—Improving.

Feb. 17.—Shown at Consultation Board. Quadriceps has been stretched above the patella.

March 8.—Sir Robert Jones orders caliper splint allowing 20° of flexion.

Reviewing this case nine months later, one cannot help wishing that one might take it in hand again in order to re-educate the quadriceps. It is just possible that later methods might have been successful.

CONCLUSION.

Detailed Diagnosis.—The functional is sometimes so elusive that no disability should be diagnosed as wholly organic without the most searching examination. One of his surgical colleagues recently told the writer that, in order to avoid overlooking anything, he now, when he sees a new case, always first asks himself, "Can there be anything functional in this?" It is not enough to form a general diagnosis. Every structure of the part must be examined. In most cases the problem is rapidly reduced within small dimensions, although within these limits it may be intricate enough.

Detailed Treatment.—Each muscle must be taught to function properly—that is to say, to contract and relax at will, and so, by acting at the proper moment with the proper degree of force, to secure complete co-ordination of all the muscles of the part. In a case of drop-foot, the man must be taught not only to walk and to raise the ankle, but also to make full use of the long extensors of the toes. In particular, in a mixed organic and functional case, the more crippling the organic disability, the more important may it be that the functional disability should be cured.

Mental Attitude of the Patient.—This is usually good. At first no doubt he is often sceptical, but this is only natural if he has for some time been under various forms of treatment with little or no result. On a bench in one of the lecture theatres in the legal department of the University of Edinburgh, a long-suffering student once carved the words, "How long, O Lord?"—and these seem to be the sentiments of many a patient who finds himself for the first time in the department. As a rule, however, he soon comes to see that if through wounds or physical or mental strain his muscles have fallen into bad habits, there is no reason why these habits should not be overcome with training. Above all, he realizes that while the training is directed by the staff, the muscles must be constantly disciplined by himself. Many of these men are very keen, and their steady but gradual progress would appear to justify the belief that there is nothing hysterical about their disability. The condition may be purely functional, but it is an abuse of language to apply to these men a term which has for centuries carried with it a more than half contemptuous suggestion of hyper-femininity.

Team Work.—The treatment of these cases is essentially a matter of team work. Before re-education, the case is seen by a surgeon; and incidentally it may be remarked that it would be no bad thing if the converse were more often practised, so that before

surgical treatment was begun the case were seen by a re-educator. If there is a doubt as to the involvement of a nerve in an organic lesion, a confirmatory report is obtained from the electrical department. After the wounds have healed, the surgeon will in some cases be called upon to restore the structures as far as possible to the normal before re-education is undertaken; in others re-education may begin at once. In either case, when the one form of treatment has reached its limit, the other should be called upon to do what it can towards removing any residual disability. In this way the case may change hands several times, and the writer is glad to have this opportunity of expressing his hearty thanks to his surgical and other colleagues for their co-operation in the work.

Above all, however, he is indebted to Lieutenant-Colonel Littlewood, Officer Commanding the 2nd Northern General Hospital. It was Colonel Littlewood's insight into the needs of these cases which led to the formation of the department, and but for his confidence and encouragement in the face of many difficulties, the department might long ago have ceased to exist. The writer's thanks are also due to Colonel Littlewood for permission to publish the above cases from the records of the hospital, and to the Medical Research Committee, without whose financial aid the department would have been without photographs.

DIGESTION OF THE ŒSOPHAGUS AS A CAUSE OF POST-OPERATIVE HÆMATEMESIS.

By J. HOGARTH PRINGLE and JOHN H. TEACHER, Glasgow.

INTRODUCTION.

Post-mortem digestion of the œsophagus, and digestion of the œsophagus occurring during life or 'œsophagomalacia,' are described in the text-books of pathology. Slight degrees of the former condition are common; the latter is stated to be extremely rare, and the connection between it and vomiting of black material or actual hæmatemesis following operation appears to have escaped recognition.

Adami and Nicholls[1] mention œsophagomalacia as an agonal manifestation in cases of cerebral disease, and Shennan[2] refers briefly to post-mortem digestion of the œsophagus. Kaufmann[3] describes post-mortem digestion in sufficient detail, and states that slight degrees of it are common—a statement which we can confirm. *Intra-vitam* œsophagomalacia of great extent is said by this writer to be rare, but a few cases of 'ulcus a digestione' have been recorded. He describes a case of cirrhosis of the liver in which there were extensive digestion and perforation very like that seen in some of the present cases; there was thrombosis in the varicose veins which he regarded as of etiological importance. Perforation of varicose veins of the œsophagus in cirrhosis of the liver has frequently been seen by one of us, but is quite a different thing from the acute digestion with which this paper deals.

In considering the subject of post-operative hæmatemesis, one must exclude those cases in which the symptom follows upon some direct surgical interference with the stomach itself, and also that class of patient who suffers from a gastric or duodenal ulcer at the time of undergoing an operation for some altogether different disease. In the latter case hæmorrhage may begin from an old-established ulcer the existence of which has not been known, and which, in other instances, may perforate with disastrous results, should the accident not be recognized.

Apart from these cases, post-operative hæmatemesis is a symptom of great importance to the practical surgeon, and associated with serious danger to the patient. Fortunately it is not of frequent occurrence, for many patients who develop this symptom die. Although the death cannot always be said to be brought about by the hæmorrhage—as many of the patients are in a state of profound toxæmia and the amount of blood vomited is frequently small—still there are cases on record where large quantities have been vomited, which could only have hastened the fatal termination. On the other hand, those patients who recover after this symptom has developed, do so only after passing through a period which is extremely critical for themselves, and not less anxious for those responsible for their treatment.

The hæmatemesis usually sets in early after the operation; but in one of the cases here reported (*Case* 4), the patient vomited blood before the operation was carried out as well as afterwards—a fact of considerable importance in its bearing on this subject. In the majority of cases that have been recorded, the amount of blood vomited at one time has been small, and this is in accordance with our personal experience of these cases. The fluid ejected is usually extremely acid, and those patients who are sufficiently conscious to be able to express themselves, frequently complain of the scalding effect which it has upon the throat and lips.

Attention seems to have been directed to the subject in the first instance by Von Eiselsberg,[4] who in 1899 reported the cases of seven patients, five of whom had undergone

operations for hernia, and two for rectal carcinoma—all of them, however, involving the peritoneal cavity. In five of these cases hæmatemesis set in after operation, and three of them (hernia cases) recovered; of the other two, one (a hernia patient) died thirty-eight hours after operation, and at the post-mortem examination "recent gastric and duodenal ulcers" were found; the other patient (a rectal carcinoma) developed hæmatemesis on the second day and died on the ninth, and post mortem a "deep duodenal ulcer" was found which "appeared to be recent." In his remaining two cases no vomiting occurred at all, but both patients died; in one "about thirty gastric erosions" were found post mortem, while in the other case (a rectal carcinoma) "numerous recent hæmorrhages were found in the gastric mucous membrane." In six of the seven cases either the omentum or the mesorectum had been ligated, and Eiselsberg considered the source of the bleeding might be explained by a retrograde thrombosis or embolism of gastric vessels from the stump of the omentum or mesorectum, followed by necrosis and digestion of the area involved.

It is quite possible that in some of the cases that have been met with this explanation is the correct one; Wilkie[5] has shown by experiment that ulceration of the stomach can be produced in this way, and that a well-defined ulcer can develop within two days of causing the embolism.

Since Von Eiselsberg's paper was published, cases of post-operative hæmatemesis have been recorded which have gone on to a fatal termination, and in which erosions of the gastric membrane have been found post mortem. Again, other cases have been reported in which no cause for the bleeding, at any rate from the stomach, could be found after death. Rodman[6] has suggested that these cases might be due to sepsis and the alteration in the blood which results therefrom, in consequence of which the blood is capable of exuding through apparently intact mucous membrane.

The anæsthetic has been blamed by some writers, but beyond acting as a predisposing cause by exciting vomiting after operation, it does not seem to us to be likely to play any part in the process.

The clinical experience of one of us (J. H. P.) in this connection has to do with 18 patients, of whom 7 recovered after going through illnesses of the gravest possible nature, which must have proved fatal in every instance had it not been for the most excellent nursing which they received. The diseases from which these seven patients suffered were very varied in their nature, but 6 of them underwent abdominal operations—viz., for gangrene of gall-bladder, 2; thrombosis of the superior mesenteric vein, 1; umbilical hernia, 1; ovarian cystoma, 1; volvulus of bowel, 1; while the seventh patient had a mamma amputated for carcinoma: as these all recovered, it is impossible to say what may have been the source of the bleeding. Eleven of the patients died, and in 4 of these a post-mortem examination was not permitted (1 umbilical hernia with extensive resection of bowel, and 3 acute suppurating appendix cases). Post-mortem examinations were made in the remaining 7 cases. Of these, one patient was operated for what proved to be a ruptured ovarian cystoma, and post mortem the portal vein was found thrombosed, so that the vomiting of blood in this case must be looked on as analogous to that which occurs in cirrhotic liver; one was a case of gall-stones, and post mortem numerous erosions were found in the gastric mucous membrane; another was a case of acute appendicitis, in which no cause for the hæmorrhage was found in the stomach, and the œsophagus was not examined (neither of us was present at this examination). The remaining four cases are reported below rather more fully, for at the post-mortem examination no explanation for the onset of the hæmatemesis could be found unless it might be the state of the œsophagus.

From the pathological side, the observation which first aroused interest in the subject was the following. In 1909, at the Western Infirmary, Glasgow, one of us (J. H. T.) performed a post-mortem examination for Sir Hector Cameron on the body of an extremely well-built, well-nourished youth, who had died about ten hours after operation on account of acute appendicitis. The patient was very ill; and the appendix was found to be gangrenous; but so far as the post-mortem appearances in the abdomen were concerned,

a successful result might have been expected. The striking feature of the examination was the presence of destruction of the lower part of the œsophagus, the presence of slate-coloured fluid in the pleural sacs, and congestion and hæmorrhage in the lungs and softening of their surface in the neighbourhood of the œsophagus. There were also air-bells in the surface of the lungs which suggested interstitial emphysema in the affected areas. The appearance suggested digestion of the œsophagus and the adjacent parts. The stomach, in contrast with the œsophagus, presented healthy characters, with only the slightest degree of post-mortem digestion.

It was felt strongly that these changes had occurred during life, and had been the cause of the fatal result. Nothing in the way of inflammatory reaction (which would have proved the *intra-vitam* nature of the changes) was found, but the 'emphysema' and hæmorrhages were regarded as very suggestive. One of the later cases (*Case* 4—J. H. P.) fills this gap in the evidence, and we also feel that too little weight was given at the time to the hæmorrhages, which have now been observed in the substance of the œsophagus and in the lungs in a number of cases, as proof of the vital nature of the digestion of the œsophagus. Pneumonic consolidation in the neighbouring surfaces of the lung has also been found, but uncertainty is felt as to the significance of this: in some cases it might be part of a hypostatic pneumonia.

Fifteen cases have now come to post-mortem examination in which we consider it most probable that digestion of the œsophagus occurred during life. In 11 of these there was vomiting of brown or black material, or actual hæmatemesis. In 8 cases the condition in the œsophagus was advanced—destruction and perforation; in 7 it was early. In 8 cases there was no digestion of the stomach. In 7 there was slight digestion of the stomach. In 9 of the cases there had been operations, and we have added 6 cases in which there had not been any operation, but in which there were similar changes in the œsophagus. A number of cases of digestion of the œsophagus have been considered and omitted as being examples of post-mortem digestion.

We are much indebted to Sir Hector Cameron, Mr. Rutherfurd, Drs. Mackenzie Anderson, W. R. Jack, A. W. Russell, and Professor Munro Kerr for permission to publish the cases in which they were interested.

PARTICULARS OF CASES.

Case 1.—**Gal'-stones. Pancreatitis. Excision of gall-bladder. Hæmatemesis. Early digestion of œsophagus. Hæmorrhages into wall of œsophagus.** (*Fig.* 443.)

M. B., female, age 24, was sent into the Royal Infirmary, Glasgow, under the care of Mr. Pringle on Jan. 14, 1914, as an urgent case, with the diagnosis of perforation of a gastric ulcer. It was stated by her friends that she had been in good health up to fourteen days prior to admission. At that time she was seized suddenly with severe epigastric pain, which was associated with vomiting. She remained in bed for five days, then resumed work, feeling well until the day of admission at 10 a.m., when she experienced a severe sharp pain in the epigastric region. She worked for one and a half hours after its onset and then went home. She vomited on two or three occasions some greenish material before she came into hospital. The bowels have been acting regularly.

The patient was very ill, the abdomen board-like and very tender. Both flanks were resonant on percussion. Lungs healthy. An immediate operation was carried out. The peritoneal cavity contained some brown turbid fluid. The omenta and mesenteries showed evidence of fat necrosis. The gall-bladder and common duct were packed with calculi. The pancreas felt extremely hard and had a deep yellow colour. The gastrohepatic omentum was much thickened and very œdematous. The gall-bladder was excised, the common duct opened, a number of stones removed, and a drain tube sutured in. The pancreas was incised freely, a quantity of dirty brown fluid escaping from the incision and cut surfaces, but the wound made in it bled freely. This wound was packed.

After operation the patient vomited continuously small quantities of dark black fluid which gave a blood reaction, and she complained of a pain behind the sternum. Just before death, which took place thirty-eight hours after admission, the vomited material was bright-red blood.

P.M. Report (No. 7606), Jan. 17, 1914.—The body was that of a young woman, well built and well nourished, but decidedly anæmic. Mid-abdominal operation wound and small drainage wound above the pubis. No jaundice.

Thorax.—The heart and the aorta presented healthy characters. The lungs showed marked

fine emphysema. The lower lobes of both showed an unusual degree of hypostatic congestion. There were no adhesions, and they stripped out quite easily, and no evidence of recent pleurisy could be made out; but it was only looked for after the recognition of the condition of the œsophagus.

Abdomen.—The liver showed advanced cloudy swelling and fatty change; being of a pale yellow colour with little of the usual red markings. The spleen was normal. The kidneys showed advanced cloudy swelling. There were numerous patches of fat necrosis scattered about the pancreas, and near the tail there was a breaking-down cavity with black necrotic appearance around the white necrosed fat. The pancreas was firm and of fairly normal colour. The duct was considerably wider than normal. The gall-bladder had been excised. The common bile-duct was much dilated and contained one faceted gall-stone, and the end of a drainage tube lay in it. The stomach was healthy in appearance. There was one small area of superficial hæmorrhage, but no post-mortem digestion. There was ulceration of the œsophagus of an irregular, slightly ragged type just above the cardiac ring, and there were many streaks of hæmorrhage in the mucous membrane running up to about the junction of the œsophagus and pharynx. In colour these were slightly dull, as if not absolutely recent. Some of the tissues surrounding the lower part of the œsophagus seemed gelatinous, and were of a dark-slate colour as if from the presence of altered blood. (*Fig.* 443.)

Case 2.—**Rupture of liver by accident. Abdominal section. Hæmatemesis. Advanced digestion of œsophagus.**

E. McC., male, age 18, was admitted to Glasgow Royal Infirmary under the care of Mr. Pringle on Dec. 16, 1914, complaining of severe pain across the abdomen. On the day previous he had been struck over the abdomen by the buffer of a pit hutch which jammed him against the wall of the pit. The abdomen was hard and board-like, both flanks resonant. Liver dullness was present. The patient was extremely ill. Pulse 108, temperature 104·4°, respirations 36.

The abdomen was opened at once in the middle line. This was followed by a furious flow of blood from an extensive rupture of the right lobe of the liver. The portal vein was clamped, and this immediately arrested the hæmorrhage. Blood in the peritoneal cavity was wiped out. The liver wound was packed with gauze. A tube was passed into the right renal pouch, and the clamp removed from the portal vein.

The patient rallied wonderfully, was well at night, and seemed to be so the next morning, but he died quite suddenly during the forenoon. It was thought that death might be due to a pulmonary embolism. The patient vomited on one occasion only, and that shortly before death, a small quantity of dark coffee-ground material being ejected.

P.M. Report (No. 7921), Dec. 18, 1914.—The body was that of a well-built, healthy-looking young man. There was a large median epigastric wound, with a second long wound running from it obliquely through the right hypochondriac region, approximately in the line of the edge of the liver.

Thorax.—The heart showed healthy characters. Embolism of lungs could not be made out. The right pleural cavity contained nearly a pint of blood-stained fluid, the left a smaller quantity of turbid, blood-stained, and very dark fluid. There was considerable anthracosis, and very marked hypostatic congestion of the lungs. The inner posterior aspect of the left lung was in a pulpy condition from advanced digestion of the parts close to the œsophagus. The condition became less on passing away from that neighbourhood, but was traceable over about a half of the lung, the posterior portions being alone affected. Where the condition was slight, there were small air-bubbles under the pleural membrane. There was a slight degree of the same condition on the inner and posterior aspects of the right lung, and in this area there were many superficial hæmorrhages. Whether the blood in the pleural cavities came from this condition or not, it was impossible to determine, but there was no gross injury of the lung to be seen. The œsophagus showed an advanced state of digestion, extending from immediately above the cardiac ring almost up to the pharynx. It was perforated at several places, and the surrounding areolar tissue was pulpy and full of black altered blood. The outer coat of the arch of the aorta was affected in this way, but the middle and inner coats were unaffected. The lower part of the trachea was intensely congested, but no perforation could be made out.

Abdomen.—The stomach presented healthy characters. It contained a considerable quantity of turbid greenish fluid, and there was no recognizable post-mortem digestion. There was a very extensive rupture of the liver, the main line of it being a laceration passing from back to front, and practically separating off the right end of the liver to the extent of about a quarter of the whole organ. This portion was in a state of necrosis. The vessels in the portal tract which had been clamped appeared none the worse. The rest of the liver showed marked cloudy swelling. The kidneys showed slight cloudy swelling. The spleen was rather large and soft. In the intestines there was nothing of note, but they were considerably distended.

Case 3.—**Anthrax with meningitis. Hæmatemesis. Advanced digestion of œsophagus.**

J. E., male, a brush-maker, age over 50 years, was sent to the Royal Infirmary on Aug. 19, 1916, with the diagnosis of a perforated gastric ulcer. From the scanty history available, the patient had suffered for many years from gastric symptoms—pain after food, with occasional vomiting—these symptoms recurring in cycles, with intervals of comfort. Since Aug. 16 he had been in bed, complaining of great pain in the abdomen, and with frequent vomiting.

FIG. 443.—Œsophagus from *Case* 1, showing the ring of ulceration ending sharply at the junction of the œsophageal and gastric mucous membranes, as well as numerous submucous and intramural hæmorrhages.

When admitted, the patient was unconscious, with pulse-rate 136, temperature 103·4°, and respirations 48 and stertorous. One of us (J. H. P.) saw the man shortly after he was brought to the ward. He was very restless. There was possibly a slight degree of rigidity of the abdomen in its right upper quadrant, but it was not great. There was extreme rigidity of his neck. The pupils were equal, of medium size, and their reaction to light was uncertain. The right optic disc was normal, and the left could not be seen—the eyes were constantly deviated to the right side. There was no evidence of any injury to the scalp or skull—no signs of bleeding from the mouth, nose, or ears, and there was no alteration in the percussion note over the skull. It was obvious he was suffering from some cerebral condition. He vomited or ejected small quantities—not more than a mouthful or two at any one time—of dark-brown fluid on five separate occasions. Death took place fourteen hours after he was admitted to hospital. The condition proved to be meningitis due to the *B. anthracis*.

P.M. Report (No. 8549), Aug. 21, 1916.—The body was that of a well-nourished old-looking man. There was very marked hypostatic congestion, and changes due to decomposition were distinct.

After the nature of the disease was made out, the exterior was very carefully examined, but no lesion of any kind could be found.

Thorax.—Both pleural cavities contained considerable excess of blood-stained fluid. The lungs were congested and œdematous, but not to a very striking degree. The trachea and bronchi were also congested. No local lesion could be found. The heart was soft and relaxed, and there was bloody staining of the endocardium. The œsophagus was found to have been digested, and seemed to have given way into the right pleural cavity, where there was slight digestion of the adjacent surface of the lower lobe.

Abdomen.—The liver showed marked cloudy swelling, and the blood in the vessels was full of gas-bubbles. The spleen was moderately enlarged, with tense glistening capsule, and ruptured during removal, exuding an abundant soft dark pulp. The kidneys showed some senile cirrhosis, cloudy swelling, and subcapsular hæmorrhages. The stomach contained a large quantity of dark-green fluid; there was considerable post-mortem digestion. There was, however, much more digestion in the œsophagus, the lining of which was black and broken down immediately above the cardiac orifice, the condition extending in diminishing degree for about five inches upwards. There was a small area of black slough immediately below the cardiac orifice. There were four small, fairly recent ulcers close to the pyloric ring. There was no intestinal anthrax lesion.

Head.—The brain was covered by a thin layer of blood occupying the interstices of the pia-arachnoid. There were myriads of small hæmorrhages on the surface of the brain and in the grey matter. The interior of the lateral ventricles was thickly studded with minute hæmorrhages, and the fluid was light red in colour. There were many minute hæmorrhages in the basal ganglia, and one hæmorrhage about the size of a kidney bean in the upper part of the right corpus striatum. The effused blood filled the lymph cisterns at the base, and was particularly abundant between the lobules of the cerebellum.

Films prepared from the fluid in the lateral ventricles and the blood in the pia-arachnoid both showed large numbers of short square-ended bacilli in chains closely resembling the anthrax bacillus, and profuse growth of that organism was obtained from the fluid in the lateral ventricles and from the pia-arachnoid, but not from any other organ or from the blood. Films of the spleen and blood showed numbers of single bacilli with definite capsules, apparently *B. aerogenes capsulatus*. Sections of the brain showed a true hæmorrhagic meningitis and numerous anthrax bacilli.

Case 4.—**Appendicitis with abscess and peritonitis. Hæmatemesis before operation. Advanced digestion of œsophagus. Fibrinous pleurisy.** (*Fig.* 444.)

L. McC., female, age 16, was admitted Oct. 2, 1918, under the care of Mr. Pringle, as a case of acute appendicitis. The patient was extremely ill, pulse 132, temperature 104·2°, respirations 44. The patient, who had previously been in good health, was seized with severe pain in the region of the umbilicus on Sept. 29. She vomited soon after, and this recurred several times. The abdomen was tense, rigid, and tender all over. Dullness was present in both flanks. Nothing unusual was made out by rectal examination. Lungs clear. The patient vomited twice after coming into the ward, and before her operation—which was done as soon as possible—about five ounces each time of a dark-brown, almost reddish, fluid. A small abscess was found at the appendix, and there was a generalized purulent peritonitis. The appendix was not removed. The abscess was drained, and a Keith's tube was passed to Douglas's pouch through a small suprapubic incision, a quantity of puriform fluid escaping through it. The patient died at 6.0 a.m. the following morning, twelve hours after admission; she vomited twice after the operation, each time bringing up a mouthful or two of the same dark-brown fluid that had been ejected before the operation.

P.M. Report (No. 9244), Oct. 4, 1918.—The body was that of a well-built, well-nourished girl. There was in very marked degree the dusky complexion which is seen in septic cases. There were two surgical wounds.

Thorax.—The heart showed some cloudy swelling. The lungs from the front were seen to be congested, but appeared generally normal. The left lung was found to be lightly adherent to the diaphragm, and on cutting the root and lifting up the lung a quantity of black fluid was seen coming from the œsophagus, and the tissues between that structure and the lung were pulpy and of dirty black colour. There was no definite digestion of the surface of the lung, but on the

FIG. 444.—Œsophagus from *Case* 4, softened and perforated in its lower portion, while its upper part shows submucous hæmorrhages.

diaphragmatic surface there were some thin flakes of fibrin, and there were some subpleural hæmorrhages. The condition on the right side was similar to that on the left, there being a thin fibrinous exudate between the lung and the diaphragm, and between the back of the lower lobe and the posterior wall of the thorax. There were numerous subpleural hæmorrhages in the inner and diaphragmatic aspects of the lung. The œsophagus appeared as a black, ragged band ; and at three points, respectively about 2 in. and 3 in. above the diaphragm (*Fig.* 444), it was perforated and black fluid was escaping. The œsophagus, lower part of trachea, and stomach were removed *en masse*. The digested condition of the œsophagus stopped abruptly at the upper surface of the diaphragm. There was no pus above the diaphragm, and it appeared highly improbable that the fibrinous exudate in the pleural sacs was due to extension of the suppuration from the abdomen, the substance of the diaphragm and the connective tissue below it appearing quite normal.

Abdomen.—There was a general purulent peritonitis, the cause of which was gangrene of the appendix. The liver and kidneys showed marked cloudy swelling. The spleen was slightly enlarged, with soft full pulp. The stomach, which was examined along with the œsophagus, contained a small quantity of slaty-grey fluid quite different in character from the black fluid which was present in the œsophagus. There was very slight post-mortem digestion of the fundus of the stomach, with minute extravasation of blood into the mucous membrane ; otherwise it presented normal characters.

Sections were prepared from part of the left lung, where the surface was markedly digested, having been in contact with the œsophagus without interposition of the pleural membrane. The areolar tissue was necrotic, and showed no reaction. The surface of the lung in parts was also necrotic. This condition involved a superficial layer of at most two to three alveoli. Beneath this the alveoli were occupied by blood. Some of the necrotic alveoli seemed also to have contained blood. Deeper still the condition passed into œdema of the lung, with more or less of hæmorrhage. There was very little sign of reaction, but polymorphonuclear leucocytes were recognized in places in greater number than would be accounted for by the presence of blood. There was marked congestion.

A section was also prepared from the surface of the right lung where there was a fibrinous exudate. There was a good deal of degenerative change in the exudate, but its character was quite distinct. The cells were to a considerable extent mononuclear, with no great number of polymorphonuclear leucocytes, and there was swelling and proliferation of the endothelium of the pleura. The lung showed a condition similar to that already described. There could be no question as to the presence of vital reaction.

Case 5.—**Excision of gangrenous appendix. Advanced digestion of œsophagus. Subpleural hæmorrhages.**

D. T., age 19, blacksmith, was admitted into the wards of the Western Infirmary under the care of Sir Hector Cameron at 1.0 a.m. on March 17, 1909. Abdominal pain and rigidity, and marked tenderness on pressure. Some distention. Temperature 101·2°, pulse 120. At operation the appendix was found to be gangrenous. The abdomen was drained. Patient gradually got worse, and died at 11.45 p.m. the same night.

P.M. Report (No. 7895), March 19, 1909.—The body was that of an extremely well-built and well-nourished youth. Post-mortem lividity marked. There was a wound in the right inguinal region, with a gauze drain.

Thorax.—The heart was normal. The pleural sacs contained a small quantity of grumous dark slate-coloured fluid. The lungs were congested, and considerable areas of the inner aspects were of slate colour, and softened on the surface. Outside these areas there were numerous subpleural hæmorrhages and interstitial emphysema, i.e., gas-bubbles in the surface of the lung. Beyond this zone of emphysema there were a few small hæmorrhages. There was no fibrinous exudate, and no definite adhesion between the visceral and parietal pleuræ. The cause of this condition was found in digestion of the œsophagus, the lower two inches of which were almost completely destroyed. The condition extended considerably higher in gradually decreasing degree. The cardiac ring was not digested, and was retaining the gastric contents to all appearance perfectly. The stomach showed only a slight degree of superficial post-mortem digestion. In other respects it was healthy.

Abdomen.—There was a general peritonitis, with fibrinous exudate and a comparatively small amount of pus. The stump of the appendix was securely closed. There was no trace of adhesions about it. There was extreme cloudy swelling of the liver. The spleen was somewhat enlarged. Nothing else of note was found.

Case 6.—**Excision of perforated appendix. Hæmatemesis. Advanced digestion of the œsophagus. Subpleural hæmorrhages and emphysema.**

I. N., age 21, was admitted to the Royal Infirmary under the care of Mr. Rutherfurd on May 11, 1909, as a case of appendicitis. The appendix was removed on the same day. It was found to be perforated, and there was much pus in the iliac fossa and pelvic cavity. The abdomen was drained. On May 13 patient vomited brown material. On May 14 she was noticed to be 'jaundiced.' She died at 2.0 a.m. on May 15.

The opinion of the surgeon was that patient was doing well until the day before her death.

P.M. Report (No. 5970), May 15, 1909.—The body was that of a well-built, well-nourished girl.

Thorax.—The heart presented healthy characters. The right lung showed some hæmorrhagic spots in the pleura on the inner aspect posteriorly. The left pleural cavity contained a quantity of turbid, slate-coloured fluid, and the gastric contents could be seen escaping into it from a perforation of the œsophagus just above the diaphragm. Practically the whole posterior and diaphragmatic surfaces of the lung were of a dark slate colour with reddish markings. The middle parts of this area were smooth, but the margins showed many gas-bubbles apparently underneath the pleura. The lung tissue underlying this area appeared to be unaffected.

Abdomen.—The field of operation appeared to be in a satisfactory condition. The liver showed extreme fatty change. The kidneys were the seat of interstitial nephritis, with cloudy swelling, and apparently fatty degeneration. The stomach was anæmic. It was ulcerated, and remarkably free from post-mortem digestion, which was recognizable only near the cardiac orifice and was quite superficial. The œsophagus, on the other hand, showed a very intense maceration, with separation of the longitudinal muscles, extending from the cardiac orifice three or four inches upwards. The wall had given way on both sides; but extravasation of contents had occurred only into the left pleural cavity, the right pleural cavity and the abdomen not being affected.

There was also digestion of the duodenum, commencing about half an inch beyond the pyloric orifice, and extending for about three inches downwards. Extravasation had taken place into the connective tissues behind the duodenum, and also below and to the right, but it was doubtful whether there had been any escape into the peritoneal cavity.

Case 7.—**Suture of perforated duodenal ulcer. Advanced digestion of œsophagus.**

J. McE., age 39, under the care of Mr. Rutherfurd. Took ill on June 10, 1914. Operation was performed on June 11, and a perforation of a duodenal ulcer was found. The perforation was sutured and the abdomen closed. The patient died on June 13. There were no distinctive symptoms.

P.M. Report (No. 7749), June 15, 1914.—The body was that of a big, rather fat subject. There was some peritonitis about the field of operation, but there had been no further leakage, and the condition generally appeared to be satisfactory. There was a small characteristic acute duodenal ulcer.

Thorax.—The heart was rather flabby and dilated. The right pleural cavity contained some clear serous fluid. The lungs showed hypostatic congestion and œdema. The left pleural cavity contained about 20 oz. of dirty green fluid with fat floating on it. The source of this was found to be the œsophagus, which was extensively digested, and perforated at two points. The changes in the œsophagus extended from immediately above the cardiac orifice to opposite the bifurcation of the trachea. The tissues were soft and ragged and of a dirty black colour. The surface of the lung was digested over a wide area, and the pleural membrane had completely disappeared, so that the surface consisted of collapsed-looking lung tissue.

Abdomen.—The stomach showed post-mortem digestion, limited to the fundus and posterior wall.

Case 8.—**Acute hepatitis? Hæmatemesis. Early digestion of the œsophagus.**

M. S., age 4½, was admitted to the Royal Infirmary under Dr. Jack on Sunday, Aug. 30, with a history of sudden development of vomiting of yellow coloured matter on the previous Wednesday. She complained of severe pain in her stomach. She became delirious on the Saturday. On the Sunday, the fifth day of illness, she vomited chocolate-coloured material. The stools were clay-coloured. Nothing further was made out after admission to hospital, where she died the following day.

P.M. Report (No. 7820).—The body was that of a fairly well-nourished child. There was marked hypostatic lividity, and general dusky coloration of the skin. This was not jaundice, but rather the coloration suggestive of intense toxic disease.

Thorax.—The heart appeared normal. The lungs showed some hypostatic congestion.

Abdomen.—The liver was considerably enlarged, and of a bright mottled red and yellow colour. In parts there was almost none of the red colour, so that it looked not unlike the liver of phosphorus or delayed chloroform poisoning. The kidneys also were pale and yellow, probably from fatty degeneration. The stomach contained a small quantity of dark-brown material suggestive of altered blood; there were no ulcerations or hæmorrhages or post-mortem digestion. The œsophagus showed marked digestion, which commenced immediately above the cardiac ring and extended up for about three inches. The muscular coat was distinctly affected, but there was no perforation. The contents of the duodenum showed distinct bile staining, but those of the lower part of the small intestine and colon were clay-coloured.

Microscopic examination of the liver showed advanced fatty change, and there was also fatty degeneration in the kidney.

Case 9.—**Pneumonia. Digestion and perforation of œsophagus. Hæmorrhages into the substance of œsophagus.**

D. L., age 13, was admitted to the Royal Infirmary under the care of Dr. Mackenzie Anderson on Oct. 3, 1914. He was extremely ill. Signs of lobar pneumonia in the lower lobe of the right lung were made out. He died, apparently from cardiac failure, on the third day of illness, two hours after admission to hospital.

P.M. Report (No. 7851), Oct. 5, 1914.—The body was that of a well-built, well-nourished, but very livid boy.

Thorax.—The heart showed slight hypertrophy of the right ventricle and some cloudy swelling. Both the lungs were adherent about the posterior part of the lower lobes. There was pneumonic consolidation of the posterior two-thirds or thereby of the right lower lobe, with marked congestion, and some hæmorrhage among the fibrous adhesions. Further out there was a very thin, fibrinous layer. The rest of this lung appeared healthy. In the left lung there were also hæmorrhages among fibrous adhesions over the inner part of the lower lobe. There was a small quantity of yellow serous fluid in the upper part of the sac, but Dr. Nora M. A. Allan, who made the post-mortem examination, was certain that there were no gastric contents. There was digestion of the surface of the lower lobe and lowest part of upper lobe over a considerable area. There was distinct congestion suggestive of vital reaction at several points, and some gas-bubbles in the fibrous tissue. The œsophagus was digested and perforated on the left lateral and anterior surfaces, and the tissues round about it seemed swollen and infiltrated with blood. There was old collapse and bronchiectasis of the lower lobe of the left lung, and marked recent œdema, possibly with some consolidation.

Abdomen.—The stomach contained a small quantity of turbid yellow material, suggestive of upper intestinal contents. The mucous membrane appeared thick, and there were a good many punctate hæmorrhages in it suggesting early post-mortem digestion. There was no breaking down. The cardiac orifice presented similar characters, but immediately above it there was advanced softening and breaking down involving all coats of the œsophagus, and there were a number of hæmorrhages into the œsophageal tissue which looked as if they must have occurred during life. This was noticed on the posterior wall, opposite to and rather above the perforation already described. The condition ceased about three inches above the cardiac ring. The liver and kidney showed marked cloudy swelling. The spleen seemed enlarged, soft with full pulp. There was a large, calcified mesenteric gland.

Case 10.—**Gallstones. Cholecystectomy. Fairly early digestion of œsophagus. Hæmorrhage into its wall.**

Mrs. I., age 46, was admitted to the Royal Infirmary on April 1, 1915, under the care of Mr. Rutherfurd. There was a history of acute illness of about seven days' duration. No jaundice. Some chronic bronchitis. The gall-bladder was excised on April 3. Found full of gall-stones, with purulent fluid and very hard walls. Patient collapsed on April 4, late in the evening, and died in early morning.

P.M. Report (No. 8029), April 6, 1915.—The body was that of a rather stout woman. There was slight lividity about face and neck. There was a closed operation wound in the right hypochondriac region.

Thorax.—The heart showed very advanced fatty infiltration, and diffuse fatty degeneration. Valves and vessels were apparently healthy. There were some old adhesions at the apex of the left lung. The œsophagus lying between the lungs was noticed to be of mottled dark-red colour, but there was no appearance of escape of its contents into either pleural sac. The posterior parts of the lower lobes of both lungs showed a very distinct and fairly general consolidation with intense congestion, and many subpleural hæmorrhages. There was no distinct digestion of the surface of either lung, but the areolar tissue between them and the œsophagus appeared a little softened and slightly infiltrated with blood. On the right side there was a distinct purulent condition. There was clearly pneumonia, and in parts it was distinctly of patchy character. It was more marked towards the inner aspect of the lung than towards the outer—that is to say, it was most marked in the neighbourhood of the œsophagus. The rest of the lungs were slightly emphysematous, and the bronchi contained much mucopurulent secretion.

Abdomen.—There was adhesion about the seat of operation, and a small quantity of bloody serous fluid welled out below the right margin of the liver. The liver showed advanced fatty change. The stump of the cystic duct was found apparently well secured. The stomach showed only slight post-mortem digestion, but immediately above the cardiac orifice there was marked softening of the œsophagus. The tissues were infiltrated with black altered blood and the muscular fibres separated, so that there must have been very nearly perforation on the right and posterior aspects. Nothing of note in the intestines was found. The spleen was somewhat enlarged, with full grey pulp. The kidneys showed some cloudy swelling.

Two microscopic sections of the œsophagus were made. One of these included the cardiac ring, and it showed advanced digestion of all the coats starting just above it. No evidence of reaction could be found, unless the following could possibly be interpreted in that way: the veins were very full of solid red clots, in the centre of one of which was a fairly bulky strand of fibrin—which suggests that there had been a clotting and a contraction followed by engorgement with fresh blood. The slightly digested part showed very superficial change, and no reaction.

Sections of the right lung showed advanced pneumonia of patchy type, more hæmorrhagic on the surface, with digestion of the pleura, but no reaction which could be related to that. The left lung showed less advanced patchy pneumonia.

Case 11.—**Cardiac valvular disease. Hæmatemesis. Early digestion of œsophagus.**

D. McR., age 22, warehouseman, was admitted to the Royal Infirmary under the care of Dr. W. R. Jack, as a case of cardiac disease, aortic and mitral, on Nov. 2, 1915. The abdomen

was tapped four times between Nov. 28 and Dec. 10 for ascites. On Jan. 18 he developed tonsillitis. On Jan. 26 he had a shivering which was the commencement of pneumonia. There was spitting of bright-red blood on Jan. 27. On the day of his death, which took place at 12.10 p.m. on Feb. 3, he was "spitting a large amount of blood; also vomiting a great deal of blood."

P.M. Report (No. 8346), Feb. 4, 1916.—The body presented the characteristic appearances of an advanced chronic cardiac valvular disease, being generally œdematous, livid, and slightly jaundiced.

Thorax.—The right lung was deeply congested, voluminous, and in the lower lobe there were a number of areas of early pneumonic consolidation. The lower lobe of the left lung was completely consolidated, being in a state of grey hepatization, and there was a thin fibrinous layer on parts of the surface. There were early pneumonic patches in the upper lobe. No infarction could be made out. The heart was enormously hypertrophied and dilated. There was old endocarditis of the mitral and aortic valves, apparently with both obstruction and incompetence.

Abdomen.—The liver, spleen, and kidneys showed pronounced venous congestion. The stomach was large, and contained a considerable quantity of slate-coloured fluid and numbers of grape-stones and portions of grapes. Venous congestion was not very marked, and while there were some quite recent hæmorrhages into the mucosa, there was no ulceration, nor evidence of old hæmorrhages. There was some post-mortem digestion towards the fundus. The orifice of the œsophagus was very much congested, and there was a small ulcer at one point, but connection with a vein could not be made out. Externally the œsophagus was extremely congested in its lower part, and the muscular tube stripped very cleanly from the connective tissues. About four inches up, this condition ceased and the appearance became practically normal. Internally the mucous membrane was deeply congested, and there were long streaks of blackening which looked like the result of hæmorrhage into the mucous coat. Higher up this tailed off into a brown discoloration resembling superficial necrosis, and about five inches from the cardia the tube became fairly normal in appearance. This condition seemed the most likely source of the hæmorrhage noted during life, and was regarded as ante-mortem digestion which happened to open a large superficial vein in the œsophagus.

Case 12.—**Puerperal eclampsia. Hæmatemesis. Early digestion of œsophagus.**

Mrs. R., age 28, IV-gravida, was admitted to the Glasgow Royal Maternity and Women's Hospital under the care of Dr. A. W. Russell on March 25, 1916, as a case of eclampsia. She was seven months pregnant. Her previous confinements had been normal. History of swelling of the legs and feet for some weeks previously was obtained. There were sixteen fits on the day of admission, and she became unconscious. On March 26 she was delivered of a macerated fœtus 3¼ lb. in weight. She remained persistently unconscious, and died on March 30.

At the post-mortem examination Dr. Teacher was informd that there had been coffee-ground vomiting, but the exact time before death had not been recorded.

P.M. Report.—The body was that of a fairly well-nourished but anæmic woman. There were marks of subcutaneous saline injections under the mammæ.

Thorax.—In the heart there were a number of subendocardial hæmorrhages, apparently quite recent. The myocardium showed some cloudy swelling, but no hæmorrhages. The lungs showed marked hypostatic congestion and œdema. At the left base there was an area of slightly more definite consolidation about the size of a marble, apparently an infarction.

Abdomen.—There were numerous pale and rather indistinct subcapsular hæmorrhages in the liver, principally over the right lobe. In section, there were no distinct hæmorrhages, but there was very advanced cloudy swelling, with fatty change and fairly marked venous congestion, and a few areas were seen of slightly larger size which may have been hæmorrhagic rather than simple congestion. The condition was characteristic of eclampsia, but not very marked. The spleen was considerably enlarged, congested, fairly firm, with abundant dark-grey pulp. The kidneys showed slight evidence of old nephritis, the surface being very slightly granular, and there were some depressed areas like arteriosclerotic patches (the aorta and main vessels, however, showed no arteriosclerosis). The cortex was very broad and yellow, apparently from advanced cloudy swelling and fatty change. No hæmorrhagic areas or infarcts. The stomach contained a quantity of slaty-grey fluid. The œsophagus appeared wide, and on opening was found to contain black fluid, and the lower four inches of it showed commencing digestion. From the clinical history of coffee-ground vomiting this (in the absence of lesion in the stomach) was probably *intra vitam* in origin, and the cause of the coffee-ground vomiting.

Case 13.—**Puerperal eclampsia. Vomiting of brown material and pain in chest. Advanced digestion of œsophagus. Hæmorrhages under pleuræ. Widespread digestion of surfaces of lungs.**

M. McS. was admitted to the Maternity Hospital on Sept. 16, 1918, under the care of Prof. Munro Kerr. She had had two fits before admission, and two occurred after admission. The usual treatment was given. She vomited some green material, but appeared to be improving on Sept. 17. On Sept. 19 she complained of soreness over the right lung and pain between the sternum and shoulders. On Sept. 20 labour commenced in the evening, and delivery was completed by forceps about 1.0 a.m. on Sept. 21. The child was macerated. On the same day she vomited brownish material at 8.0 a.m. She suffered from a "sore cough," and again vomited brown material at 3.0 p.m. She died at 9.40 p.m. on Sept. 22.

P.M. REPORT.—The body was that of a strongly built, well-nourished young woman.

Thorax.—The heart showed some cloudy swelling, otherwise it was healthy. There was much hæmorrhage about the surface of both lungs under the pleura, distributed principally up the back and inner aspect of both lungs, not only at the base, but also to a considerable extent near the apex. The right lung showed a somewhat patchy, but well-developed, pneumonia. The lower four inches or thereby of the œsophagus was reduced to shreds, and the connective tissue around it was in a gelatinous condition, and black from infiltration with altered blood. There was also distinct digestion of the portions of both lungs adjacent to the œsophagus. The digestion was less marked, but still present, above the level of the bifurcation of the trachea. It did not extend beyond the cardiac orifice, and there was no digestion of the stomach and no erosion or ulceration. The contents of the stomach were blackish from the presence of altered blood.

Abdomen.—The liver was large and of mottled-red and yellow colour, and there was very advanced cloudy swelling. There were none of the hæmorrhages which are seen in many cases of eclampsia. The spleen was slightly enlarged and soft. The kidneys showed well-marked cloudy swelling and some masking of the markings and congestion suggestive of subacute nephritis.

Case 14.—**Fracture of femur. Abdominal section. Hæmatemesis. Early digestion of œsophagus.**

J. S., age 52, was admitted to the Royal Infirmary on Nov. 17, 1918, under the care of Mr. Rutherfurd, with a history of having fallen from the footplate of a locomotive, and sustained injury to the left hip. There was found to be a fracture of the neck of the left femur. A few days after admission he complained of abdominal pain, which was relieved by an enema. The stools were suggestive of blood being present, but examination gave a negative result. On the evening of Nov. 27, patient vomited a considerable quantity of material containing stale blood, and the abdomen became distended and rather tense, with dullness in both flanks. The abdomen was opened the following morning, but no free fluid was found, and nothing was found in the intestines or stomach. The abdominal pain continued, but without further vomiting. The abdomen remained quite soft until the patient died.

P.M. REPORT (No. 9299), Nov. 30, 1918.—The body was that of a small, rather poorly nourished man. There was marked eversion of the left foot, the hip was fixed, and there was a good deal of swelling around it.

Thorax.—The lungs were rather atrophic, and there was an early bronchopneumonia in the upper lobe of the right lung. The heart was large and powerful, there being distinct hypertrophy of the left ventricle. There was some atheroma of the coronary arteries. No valvular lesion.

Abdomen.—The liver showed some cloudy swelling. The spleen was rather large and soft, and there were old adhesions over it. The kidneys were about normal in size, and did not show definite interstitial change, but the arteries were somewhat thickened. There was no pancreatitis. On proceeding to remove the stomach, the œsophagus was found to be very large, being dilated immediately above the cardiac ring to a diameter of nearly an inch and a half. This condition extended up for about four inches, and then the tube returned gradually to the normal size. There was no perforation, but the exterior of the tube was blackened in patches over the dilated part. This was most noticeable on the left side, and there was one bulge which suggested yielding of the wall. The œsophagus was found to contain a large quantity of black fluid, which clearly was altered blood. The interior of the dilated portion was obviously in a digested condition. Most of the mucous coat was softened, and a good deal of it was dissolved, and at the point corresponding to the bulge there was what looked like ulceration into a vein. The stomach was full of black turbid fluid. There was no ulceration, and digestion could not be made out. The whole organ felt rather soft. The intestines were irregularly contracted. There was no obstruction.

There was a fracture of the neck of the femur close to the head, and impaction of the neck into the trochanters. The head was loose. There was no sign of healing.

Case 15.—**Excision of gangrenous appendix. Hæmatemesis. Early digestion of œsophagus.**

A. M., age about 20, was admitted under the care of Mr. Rutherfurd on Nov. 29, 1918. Two days before admission patient had pain in the right side of the abdomen, accompanied by sickness and vomiting. On admission, the abdomen was quite lax, with slight tenderness over McBurney's point. On Nov. 30 the abdomen was opened. Appendix found gangrenous in distal third. Appendicectomy performed and abdomen closed. A few hours after operation patient became very sick, and during the night vomited a quantity of dark coffee-coloured fluid. Died on evening of Dec. 1, twenty-eight hours after operation.

P.M. REPORT (No. 9301), Dec. 2, 1918.—The body was that of a very well-built and very well-nourished young woman. There was a closed operation wound in the right iliac region. Hypostasis was very marked.

Thorax.—The heart showed advanced cloudy swelling of the muscle; it was otherwise normal. The lungs showed marked hypostatic congestion and very slight œdema. In view of the history, the œsophagus was cleared, and was found to be dilated immediately above the diaphragm, and at one point on the lateral wall about an inch and a half above the diaphragm, and rather to the left side, there was some black colour and a slight tendency to local bulging. On opening, the tube was found to contain quantities of thin black fluid. The inner surface was extensively but superficially digested, and at a point corresponding with the bulging above mentioned, there was a little area which looked like an ulceration into a vein. It was, however, not found possible to

pass a fine probe into the vessel. The digestion extended from immediately above the cardiac ring to within about two inches of the glottis. There was no hæmorrhage into the walls of the œsophagus, the dark appearance apparently having been due to the black contents showing through the thinnest part of the wall.

Abdomen.—The stomach contained quantities of similar black fluid. There was no ulceration at any point, and no punctiform hæmorrhages. The fundus felt rather softer and was more relaxed than the pyloric end, there being apparently very slight digestion, but it did not amount to breaking down of the mucous membrane. The liver and kidneys showed some cloudy swelling. The spleen was rather large, but without marked fullness of the pulp. There was no general peritonitis. The region of operation was well shut off by fibrinous adhesions. There were a few ounces of thick fluid in the neighbourhood of the stump and in the pelvic cavity. The condition looked one from which the patient might have recovered.

DISCUSSION.

Before proceeding to discuss the evidence that the digestion of the œsophagus is a process which had occurred during life, it must be admitted that in all probability the digestion continues after death, and that some of the appearances described may be due to this. On the other hand, these post-mortem changes would have the effect of destroying the indications of vital reaction, such as the formation of fibrin in the pleural sacs, and of obscuring small hæmorrhages into the tissues of the œsophagus. This may well have occurred in some of the cases which showed very advanced destruction of the œsophagus and adjacent structures. Moreover, *Cases* 14 and 15, in which the changes were not advanced, might on this account have been passed over as post-mortem in nature but for the clinical observation of coffee-ground vomiting.

Perhaps the most important of all the records is that of M. B. (*Case* 1—J. H. P.). The œsophagus from this patient exhibited (*Fig.* 443) numerous submucous and intramural hæmorrhages of varying extent, many of them comparatively large; and while for the most part the mucous membrane over them is intact, a superficial disintegration of the membrane has taken place over some of them, resulting in the development of more or less widespread 'erosions.' We regard this case as showing an early stage of the condition, remarkably free from post-mortem change. In addition, there is a very definite ring of ulceration round the entire circumference of the cardiac extremity of the gullet, ending abruptly in a very sharply-cut margin at the junction of the œsophageal with the gastric mucous membrane, and becoming less marked the further it recedes from the stomach.

It is to be noted that in all cases this sharply-defined ulceration of the mucous membrane has been observed at the very termination of the œsophagus. In fact, the lower part of the gullet has always appeared to have suffered more severely than the upper; and when perforation has occurred, it has always been found low down in the tube. Possibly the constriction of the gullet by the diaphragm is responsible for this ring of ulceration; for it would appear that the compression exerted by the diaphragm on the œsophagus is very tight, as it has been remarkable how empty the stomach has been of blood in nearly all the cases we have examined.

Almost as important as *Case* 1 is *Case* 4 (J. H. P.). In the specimen from this case (*Fig.* 444) there is evidence of submucous hæmorrhages in the upper part of the tube not unlike those seen in *Case* 1.

If the hæmorrhages, which would undoubtedly predispose to erosion and perforation of the walls of the œsophagus, occur during life, as we believe, the hæmatemesis can be explained by the erosion of the mucous membrane over and around them. The chief fact in favour of these being the result of a process commencing *intra vitam* is that they are real intramural hæmorrhages and not post-mortem stainings.

We particularly draw attention to the fact that in *Case* 1 (J. H. P.) the patient complained of a retrosternal pain, for this is highly characteristic of œsophageal irritation—e.g., by a foreign body caught low down in the gullet. Nothing suggestive of this was observed in any of the other cases except *Case* 14 (puerperal eclampsia—Dr. Munro Kerr), but then they were mostly much more rapid in their course than these two.

The second fact of importance in *Case* 4 (J. H. P.) is that in the left pleural cavity evidence of the reaction of the tissues to the irritant in their immediate neighbourhood

was observed in the form of a fibrinous exudate on the pleural surface, and inflammatory reaction in the superficial alveoli of the lung adjacent to the œsophagus. In this case the œsophagus was perforated, but the extravasation had not extended into the pleural sac. It may quite well have happened in several of the cases in which this had taken place, that any fibrin, which might have formed, had been digested ; but in several cases the hæmorrhages into the lungs, and the small widespread subpleural ecchymoses, remained as evidence of the vital nature of the condition.

We see no improbability in the suggestion that perforation and leakage from the œsophagus may actually be the final cause of death from shock. Nor is it impossible in our opinion that a condition such as is shown in *Fig.* 443 might be recovered from, if there were no lethal disease present at the same time. A far worse local condition of the œsophagus must have been induced in many instances where caustic fluids have been swallowed and in which recovery still occurred.

What we believe takes place in these cases is that in the course of a toxic disease gastric juice escapes into the œsophagus and may not be expelled, but, lying in the lumen, is able to start and establish a process of digestion of the already devitalized coats of the gullet. We believe that the œsophagus from *Case* 1 exemplifies an early stage of this process ; and it is to be observed that in *Case* 4 the patient vomited blood before the operation was commenced, which is at least suggestive of the presence at that time of a state analogous to that found in *Case* 1. It appears to us that any operation, with the resulting shock, and the general anæsthetic if one has been employed, must only be looked on as predisposing conditions acting as devitalizing agencies.

This view is supported by consideration of those cases in which no operation had been performed. These were cases either of acute infections—two pneumonias and one anthrax ; or intense toxic conditions—two puerperal eclampsias and one obscure condition in which acute degenerative change in the liver was the principal feature. We hold that these cases substantiate our contention that digestion of the œsophagus is a process which is liable to develop in any class of case in which the vitality of the tissues is greatly reduced, and in which vomiting of active gastric juice happens also to occur.

SUMMARY AND CONCLUSIONS.

Post-operative vomiting of black material or hæmatemesis is a symptom of great importance to the practical surgeon. In some cases the cause of these symptoms appears to be digestion of the œsophagus. This condition may vary in different cases from superficial erosion of the interior of the œsophagus to perforation or widespread destruction of the tube and damage to adjacent structures. The vital nature of the condition is shown by the presence of hæmorrhages into the œsophageal wall, lungs, and pleuræ ; while, in one case at least, inflammatory reaction was observed in the lungs and pleural sacs.

The vomiting of black material or actual hæmatemesis was observed in eleven out of the above fifteen examples of digestion of the œsophagus found at post-mortem examination. In six of the cases no operation had been performed, but these were all of a severe infective or toxic nature. In contrast with the state of the œsophagus, there was usually little or no digestion of the stomach.

In conclusion, we submit that digestion of the œsophagus may occur during life, and that as a result blood may be vomited.

That this digestion may take place in any disease in which great lowering of vitality occurs.

That ante-mortem digestion of the œsophagus is one cause of post-operative hæmatemesis.

REFERENCES.

[1] Adami and Nicholls, *Principles of Pathology*, 2nd ed., vol. ii, p. 408, London, 1911.
[2] Shennann, T., *Post-Mortems and Morbid Anatomy*, Edinburgh, 1912.
[3] Kaufmann, *Specielle Pathologische Anatomie*, 5th ed., p. 388, Berlin, 1909.
[4] Von Eiselsberg, *Archiv für klin. Chirurgie*, vol. lix, p. 837.
[5] Wilkie, *Edinburgh Med. Jour.*, 1911, vol. vi (n.s.), p. 139.
[6] Rodman, *Jour. Amer. Med. Assoc.*, 1900, vol. xxxiv, p. 1509.

BONES SHOWING THE EFFECTS OF GUNSHOT INJURIES,

IN THE ARMY MEDICAL COLLECTION NOW ON EXHIBITION IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

By Professor ARTHUR KEITH, F.R.S., Conservator of the Museum, and Captain MORTON E. HALL, C.A.M.C.

By the end of 1918, over 4000 specimens had been forwarded to the Museum of the Royal College of Surgeons of England by the Medical Services of the British Imperial Forces, to illustrate the nature of the wounds and diseases which are met with under conditions of modern warfare. As the specimens arrived, they were numbered, registered, and suitably stored, every effort being made to obtain and keep a full history of each specimen. Of these specimens, 1155 have been prepared, mounted, described, and placed on exhibition in the Museum of the College, 688 of them as 'wet' preparations to show the damaged condition of the soft tissues, and 467 as macerated preparations to show the effects of gunshot injuries on the skeletal parts of the body. The 'wet' preparations are being investigated, prepared, described, and constantly added to by Professor S. G. Shattock and Mr. Cecil Beadles. Here we propose to deal with the macerated series only, in which the various parts of the body are represented as follows :—

Injuries affecting	the	calvaria or cranium	109
,,	,,	face	37
,,	,,	spine	32
,,	,,	pelvis and sacrum	36
,,	,,	hip-joint	5
,,	,,	femur	76
,,	,,	knee-joint	14
,,	,,	leg	49
,,	,,	ankle-joint	9
,,	,,	foot	7
,,	,,	sternum	1
,,	,,	ribs	3
,,	,,	scapula	24
,,	,,	clavicle	14
,,	,,	shoulder-joint	3
,,	,,	humerus	27
,,	,,	elbow-joint	5
,,	,,	forearm	13
,,	,,	carpus and hand	3
Total number of macerated specimens			467

How the Collection was Formed.—Before proceeding to describe the macerated specimens and draw from them the lessons they teach, it will be well to give a short account of the circumstances under which the Army Medical Collection has been brought together.

In November 1914, a Committee was formed, under the presidency of the Director-General of the Army Medical Services—then Sir Alfred Keogh—to compile a Medical History of the War. One of the aims of this Committee was to collect from casualty clearing stations and military hospitals examples of wounds and diseases, and to examine and preserve such specimens, so that, when the Medical History came to be compiled, the recorders would have access to an ample supply of first-hand material on which to base

their descriptions and conclusions. It was also realized by the Committee that such specimens, if suitably preserved, would constitute instructive documents which might be profitably examined and studied, not only by military surgeons of to-day, but also by their successors for many generations to come.

In the earlier months of the War every endeavour had to be concentrated on the immediate medical requirements of the Army, and hence it was not until May, 1915, that measures were taken to put the scheme of the Committee into operation. Sir Walter Fletcher, who had undertaken the secretaryship of the Medical History Committee in addition to his onerous post as secretary to the Medical Research Committee, approached the Council of the Royal College of Surgeons on behalf of the Army Council, to obtain its assistance in the formation of an Army Medical Collection. The Council of the College responded at once by placing its museum staff and workrooms at the disposal of the Army Council.

Although circular memoranda were issued to medical officers, detailing the aims of the Committee and the methods to be observed in selecting, preserving, and dispatching specimens, the results were meagre, and remained so until the commencement of 1916, when the Director-General of Medical Services in France—then Sir Arthur Sloggett—placed Lieutenant-Colonel T. R. Elliott in charge of this particular service. Specimens then arrived in numbers; they were selected examples, preserved by the latest and best methods. The co-operation was enlisted of the younger pathologists and surgeons attached to clearing stations and hospitals in France—Captain Herbert Henry, Captain T. G. Shore, Major G. Richardson, Captain Adrian Stokes, Lieutenant-Colonel E. M. Cowell, Major S. W. McNee, Captain A. Petrie, and many others. At a later date the Canadian and Australian Medical Corps organized similar collecting services; so that although the greater part of the collection now in the Museum of the Royal College of Surgeons represents the effort of the Royal Army Medical Corps, yet large sections of it have been gathered by the Colonial sister services. These sections will be set up as Army Medical Collections in Canada and Australia.

There was no intention at the outset of forming a separate series of macerated specimens. It is true that almost from the commencement specimens of this kind were received from France, particularly from Major G. Richardson, who adopted a special process of his own for cleansing bones, and has enriched the collection by some of the most instructive specimens to be found in it. The movement which led to the formation of a macerated series came from Cambridge University. When Lieutenant-Colonel Sir John Bland-Sutton was appointed by the Director-General, in the spring of 1917, to stimulate and organize the collection of specimens from home sources, he found that a collection of macerated specimens, showing excellent workmanship, had been gathered in the Pathological Museum of the University of Cambridge. The material from which the specimens had been prepared was obtained from No. 1 Eastern General Hospital, under the command of Lieutenant-Colonel Joseph Griffiths, and represented lesions sustained by soldiers during the opening years of the war—lesions of bones in all stages of repair and disruption. They were the work of Sergeant F. A. Izzard, who had applied to them a simple and expeditious method of maceration he had elaborated during many years of service as assistant in the Pathological Department of the University. Sergeant Izzard has printed and distributed a leaflet giving an account of his method, which, in our opinion, yields far better results than any other; it is expeditious, and preserves unharmed the most delicate structural features of bones, be they diseased or healthy.

Description of Method used by Sergeant F. A. Izzard.

A preparation from the operating theatre or post-mortem room is placed in an earthenware jar or pot of suitable size filled with water at a temperature of 80° F., and at this temperature the water is maintained day and night for four days. On the fifth day the water is poured off, and the jar again filled up with fresh water at the same temperature (80°). Every fifth day this operation is repeated. By the tenth, fifteenth, or twentieth day it will be found that the soft tissues will have separated from the bones and left them exposed. Sergeant Izzard is of opinion that the greater the amount of soft tissues left on the bones, the better and quicker does the process of macerating proceed; there is, he says, no greater error than in seeking to expedite the process

by clearing off all the soft tissues before placing the part in the macerating pot. All that should be done then is to make incisions in the soft parts, merely skin and fascia deep, so that the macerating fluid may have free access to the underlying parts. The process is one of bacterial digestion. A certain degree of stench accompanies the process. When it is seen that the bones are exposed and separated from the soft tissues, they are taken from the macerating pot and scalded with two or three kettles of boiling water, which will clean all excess of filth from the bones. The bones are then scrubbed with soap in boiling water, a tooth brush being used for this purpose, the ordinary nail brush being much too coarse. When thus scrubbed, the bones are again scalded in boiling water to remove soap and any other matter which may still cling to them. They are then dried in the sun or by the fire. When dried, they are examined to see if they are free from grease; if grease is present. they must be placed in benzoline for two days, the benzoline being given free access to the medullary cavity by drilling minute holes if necessary. When removed from the benzoline retort the bones are usually dry and of a good colour; but if whiteness is desired, this can be obtained by placing them for several days in a 10 per cent solution of peroxide of hydrogen —distilled water being used in the solution. This bleaching solution may serve for several relays of specimens before becoming inert.

We have given Sergeant Izzard's method in some detail because of the excellence of the specimens which it has yielded in his hands. The Cambridge specimens which were thus prepared became the nucleus of the Army Medical Collection of Macerated Specimens at the Royal College of Surgeons. They were sixty in number; but unfortunately in several instances it was impossible to obtain a history of the case from which they had been derived. Sergeant Izzard went to France in March, 1917, and, working under Captain T. G. Shore, prepared a particularly valuable series of specimens. For over a year he has continued this work for the Army Collection at the Museum of the Royal College of Surgeons.

In mounting preparations showing the explosive or disruptive forms of gunshot injuries, no attempt has been made to represent the scatter or disruption of fragments; in every instance the fragments have been again fitted together, so that in the mounted macerated specimen we have a representation of the *lines* along which the skull or bone-shaft ruptured when struck by the missile.

Having thus given an account of the formation of the Macerated Collection, we shall now proceed to describe the types of injury which are met with in the various bones of the body, commencing with the cranium or brain-containing part of the skull.

INJURIES TO THE CRANIAL PART OF THE SKULL.

As already mentioned, there are 109 preparations of cranial injury. In Section I of this article we describe what may be called the type specimens; in Section II we illustrate variants of the type specimens.

Section I.—TYPE SPECIMENS.

We have divided these injuries into three main groups: (1) *Contused*; (2) *Penetrating*; (3) *Perforating* (through-and-through).

Group 1.—Contused Injuries of the Cranium.

The term *contused* has been used to include a variety of injuries in which the projectile did not enter the cranial cavity. In this group are included injuries due to a projectile striking the skull a direct blow but with insufficient momentum to carry it through the cranial wall, or those where an area of skull is crushed by a missile—such as a fragment of shell or spent bullet. This group also includes injuries resulting from a tangential or glancing blow from a projectile—such projectiles usually having considerable momentum. In the collection there are 67 specimens showing contused injury. We have divided such injuries into four classes: (*a*) *Internal table only*; (*b*) *External table only*; (*c*) *External table slightly, very marked internal table*; (*d*) *Grooved and massive, involving both tables over an extensive area.* Each of the classes has again been classified on an anatomical basis according to the bone affected, as frontal, parietal, occipital, etc.

a. **Contused Injuries without Depression of External Cranial Table but with Fracture of Inner Table.**—There are 5 specimens in the War Office Collection showing the above type of injury, 4 of the parietal bone and 1 of the occipital bone. The reason why this type of injury is so sparsely represented is probably owing to the low mortality which attends its infliction. The external table, being unbroken, prevents the entrance of infection. Also, when recognized by the surgeon, this type of injury has responded most readily to radical operative treatment, and for this reason a description of the specimens will be of value.

Two specimens, Nos. 1.201 and 1.202, have been selected to illustrate this type of injury (*Figs.* 445*a*, 445*b*, and 446*a*, 446*b*).

No. 1.201 shows an irregular oval area (29 × 18 mm.) on the external table of the left parietal bone, near its postero-medial angle, where the missile struck. It is slightly discoloured, but there is no fracture or depression. The internal view shows an area of the internal table, irregularly oval in shape (28 × 25 mm.), which is semi-detached from the diploe opposite the area of impact. There are two fragments. The semi-detached area involves the terminal branches of the middle meningeal vessels of the left

FIG. 445*a*.—No. 1.201. External view, showing the area of left parietal bone struck by the projectile. No fracture or fissuring is observed at point of injury.

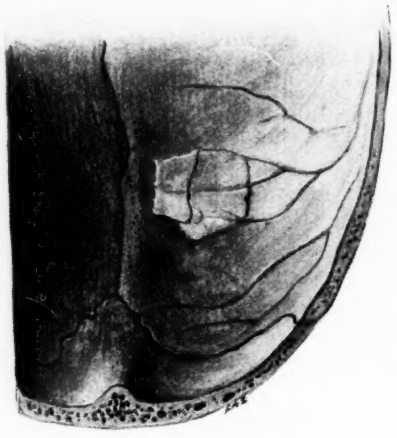


FIG. 445*b*.—No 1.201. View of the internal surface of calvaria, showing the extent of fracture, with two detached fragments.

side. The soldier was wounded on April 12, 1917. On admission to hospital he had a gutter scalp wound near the left parietal eminence, and was in a comatose condition. The scalp wound became rapidly septic, and he died April 22, ten days after injury. At the autopsy a considerable subdural hæmorrhage was found at the site of fracture, with pulping of the cerebral cortex. No note was made of the condition of the dura. In this case it is probable that the missile did not actually strike the bone, the fracture being produced by the lateral displacement of the soft tissues which lay in its track.

Specimen No. 1.202 shows a contused injury just above the eminence of the left parietal bone. At the point of impact of the missile there is a circular area of the external table, 30 mm. in diameter, which is discoloured, but which shows no depression or fracture. From the posterior margin of this area a fissure extends across the vertex to the right temporal line. The internal table is depressed—the depressed area showing two fissures, but no separation of fragments. A fissure, corresponding to that seen on the external surface, extends across the vertex, but does not extend into either fissure at the site of fracture. Unfortunately we have been unable to obtain a clinical history of this specimen.

Specimen No. 1.2023 demonstrates a more severe type of injury of the inner table. The external surface of the calvaria, near the antero-medial angle of the right parietal

bone, presents an oval area 30 × 20 mm. on the outer table, which is bruised, but not fractured or depressed. The inner surface shows complete fracture and detachment of the inner table, over a pear-shaped area 20 × 30 mm. Five fragments were found embedded deep in the substance of the left hemisphere There was a gutter scalp wound, 8 cm. long, over the site of fracture. This specimen was presented to the collection by Dr. Harvey Cushing, of the American Medical Service, and has been fully described by him in this journal.*

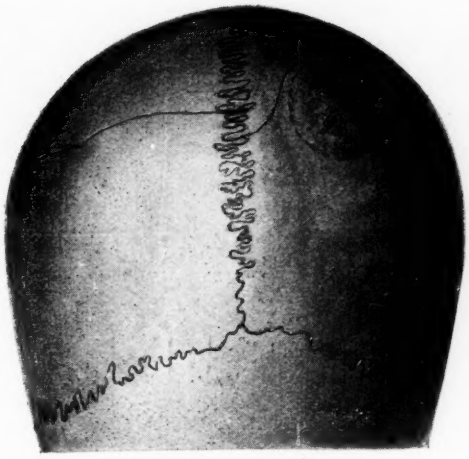


FIG. 446*a*.—No. 1.202. External surface of calvaria, showing the circular discoloured area of impact on the left parietal bone.

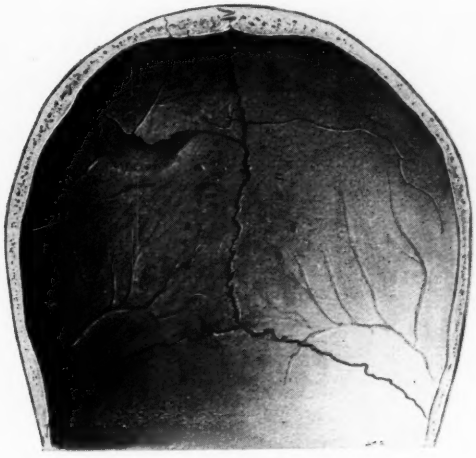


FIG. 446*b*.—No. 1.202. View of the internal surface of the calvaria, showing a depressed fracture of the inner table opposite the discoloured area.

We do not propose to discuss the mechanism underlying this type of fracture; we simply point out that the internal table is more brittle and less supported than the external table. The internal table therefore suffers most, and develops a depressed fracture; not unusually, as in specimen No. 1.2023, its fragments are driven deeply into the substance of the brain. In specimen No. 1.201, the injury to the internal table is local; while in specimen No. 1.202, fissures extend a considerable distance from the point of impact.

b. **Contused Injuries of External Table, without Injury to Internal Table.**—There are 3 specimens in the Collection showing the above class of injury; 2 are of the frontal bone, and 1 of the parietal bone. Each of the specimens shows a more severe injury of another class. Specimen No. 1.131 may be taken as a type. There is a contused wound of the frontal bone above the right superciliary eminence, with an aperture 7 × 5 mm. in the external table, opening into the upper limit of the frontal sinus; the inner table is splintered and detached. Above the right frontal eminence a thin fragment of metal is lodged in the external table, but with no injury to the inner table. The soldier was wounded on June 7, 1917. He suddenly became unconscious on June 19, and died the same day. An abscess of the frontal lobe was found at the autopsy, as a sequel to the major injury. In the three specimens in the collection with injury to the external table, the injury has been the result of small shell-fragments with sharp margins, and evidently with insufficient momentum to penetrate the inner table.

c. **Contused Injuries in which the Outer Table shows Slight Injury and the Inner Table Marked Comminution.**—There are 16 specimens in the Collection showing the above variety of injuries, of which 5 are of the frontal bone, 11 of the parietal, and 1 of the occipital. In this type of injury, in contrast to the lesions we have grouped in class (*a*), there is fracture of the outer table, the fragments of which are driven inwards

* *Brit. Jour. Surg.* 1918, April, p. 567.

and act as an aid in the destruction of the inner table. In the majority of the specimens, the fragments of the fractured inner table have been driven into the brain substance, producing a laceration of the dura.

Specimen No. 1.204 is an example of this injury (*Figs.* 447*a*, 447*b*). There is a small depressed fracture in the upper part of the Rolandic area of the left parietal eminence,

FIG. 447*a*. No. 1.204. External surface of calvaria, showing depressed fracture of the outer table of the left parietal bone. There is no fissuring.

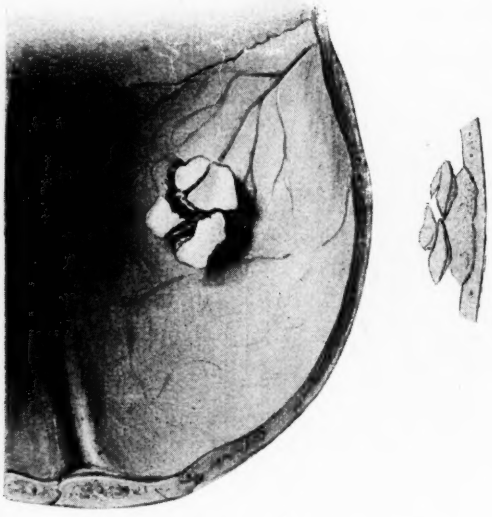


FIG. 447*b*.—No. 1.204. Showing the fracture of the inner table, with several detached fragments. The marginal diagram represents a transverse section through the bone at the point of injury.

caused by a fragment of shell. There is no fissuring of the outer table, which is merely crushed into the diploe, but the inner table is splintered into several fragments which are detached. The history of this case is not known.

Specimen No. 1.2024 shows a more marked injury to the outer table (*Fig.* 448*a*). There is a radiating fissure of the right parietal bone near the inferior margin. An irregular area 33 × 9 mm. is splintered into five fragments, three of which are depressed

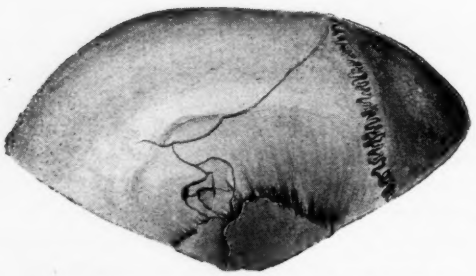


FIG. 448*a*.—No. 1.2024. External surface of the right parietal bone, showing a depressed fracture with fissuring.

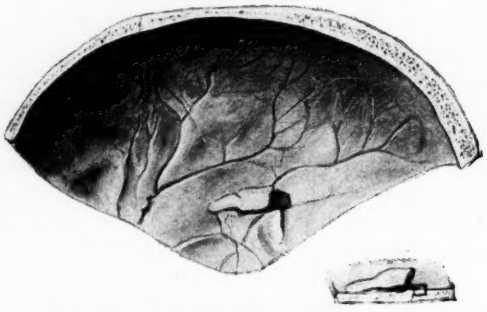


FIG. 448*b*.—No. 1.2024. View of internal surface, showing injury of inner table. The fragments are depressed, and one fragment is missing. The underlying meningeal vessels were ruptured.

and driven into the diploe. From this area a fissure extends to the coronal suture near the antero-medial angle. A second fissure extends downwards to the base. The inner table under the depressed area of the outer table is comminuted, with depression of the fragments, one of which was entirely detached and driven into the underlying cortex. The patient was wounded Aug. 18, 1917. The wound of the scalp was excised, and no

fracture could be felt ; there was no evidence of cerebral injury. There were also wounds of the right arm and shoulder. He became comatose, and died Aug. 22, four days after injury. The posterior branch of the meningeal artery was found to have been lacerated by the detached fragment of the inner table (*Fig.* 448*b*). There was no sepsis of the cortical tissue.

Specimen No. 1.2656 (*Figs.* 449*a*, 449*b*) is a portion of left parietal bone which was removed by a trephining operation to relieve a paralysis of the right arm. The operation was followed by gas-bacillus infection of the brain, and death two days later. There is an oblong aperture 30 × 10 mm. in the specimen, in which the bone fragments —of which at least two have necrosed—have been replaced *in situ*. It will be noted that the area of the inner table affected, 43 × 33 mm., is considerably greater than that of the outer table. The fragments of the inner table have been completely detached

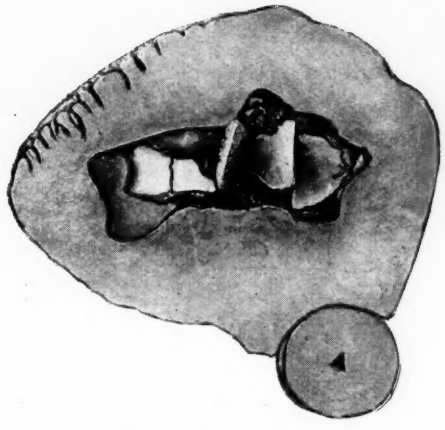


FIG. 449*a*.—No. 1.2656. External surface of a portion of left parietal bone removed by trephining operation to relieve a paralysis of the right arm. It shows an oblong aperture, in which the fragments have been replaced *in situ*.

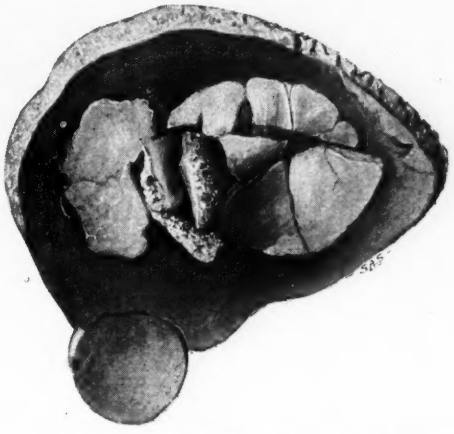


FIG. 449*b*.—No. 1.2656. A view of the internal surface of the same specimen, showing the fragments of bone *in situ*. The area of inner table involved is extensive in comparison with that of the outer table.

d. **Contused Injuries of the Grooved and Massive Variety.**—The Collection contains 44 specimens of this type of injury, 10 of the frontal bone, 23 of the parietal, 7 of the temporal, and 4 of the occipital. This type of injury, the commonest in the cranial series, comprises fractures of a major character in which the skull shows a massive crushing lesion, often the result of a blow from a large shell-fragment striking with diminished momentum. In this class we also include the so-called 'grooved' type of injury resulting from a glancing or tangential blow by a rifle bullet of high velocity. This classification has been decided upon largely because we have found that the fractures and fissuring produced by both kinds of missile are similar in character.

Specimen No. 1.021 (*Fig.* 450) is an excellent example of massive crushing injury of the calvaria. There is extensive comminution of the left parietal bone, with numerous gaping fissures extending forwards, backwards, and across the remaining portion of the calvaria. The soldier was admitted on March 11, 1917, to No. 2 Canadian Casualty Clearing Station, in an unconscious condition. The date of injury is not known. On admission he had a linear scalp wound, two and a half inches long, over the posterior portion of the left parietal bone, to the left of the sagittal plane. The wound was excised and some bone fragments were removed. He died March 16, but no record of the autopsy is available.

Specimen No. 2.444 shows a less extensive crushing injury of the calvaria (*Fig.* 451*a*, 451*b*). There is a large aperture in the frontal bone 62 × 30 mm., irregular in outline, just above the lateral angle of the left orbit. The wound was enlarged by the surgeon. From

the medial margin of the aperture a wide fissure extends across the body of the frontal bone, with branches, one to a point above the lateral angle of the right eye, another towards the coronal suture, while a third enters the right orbit. Numerous fissures

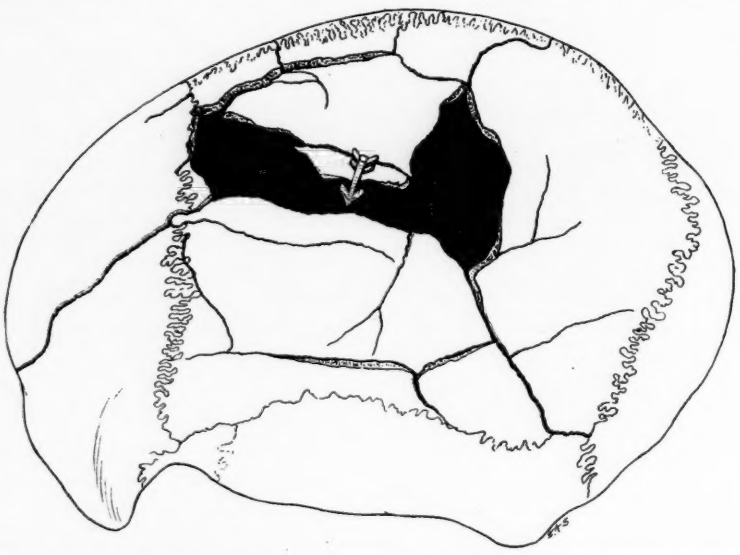


FIG. 450.—No. 1.021. Lateral view of calvaria, showing extensive comminution and fracture of left parietal bone. The arrow indicates the direction of projectile. The fragments in the region of the blow have been entirely separated, and some have been removed by operation. The main area of fracture is 9 × 50 mm., and numerous fissures extend from the margins in every direction, some of them gaping widely.

extend from the primary wound towards the base. Apparently a second missile has entered the inner wall of the left orbit. The floors of the anterior and middle cranial fossæ are fissured and shattered to a marked extent (*Fig.* 451*b*). Both maxillary bones

FIG. 451*a*.—No. 2.444. Left lateral view of skull, showing aperture in frontal bone with fissures extending across the body of the bone. The shattering of the wall of the orbit is also shown.

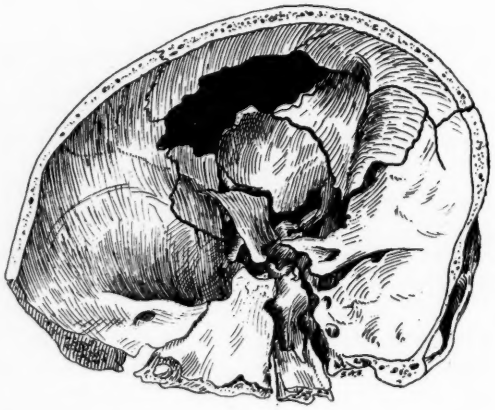


FIG. 451*b*.—No. 2.444. Internal surface of the calvaria, showing aperture in frontal bone, with extensive fracturing of left great wing of sphenoid and of floor of middle and anterior cranial fossæ.

are fractured. The bones of the face are remarkably thin. The soldier was wounded on June 11, 1917; the wound was explored and bony fragments were removed eight days later, and he died June 21. The autopsy findings are not known.

Specimen No. 1.28 (*Figs.* 452*a*, 452*b*) shows a type of lesion due to a tangential blow from a shell fragment. There is a depressed linear fracture situated on the posterior inferior aspect of the right parietal eminence. The missile apparently entered at the anterior end of the fissure, driving inwards the two tables of the calvaria. The aperture thus produced is oval in shape, and measured 40 × 9 mm. The external margin at the anterior half of the aperture is depressed, while in the posterior half the external margin

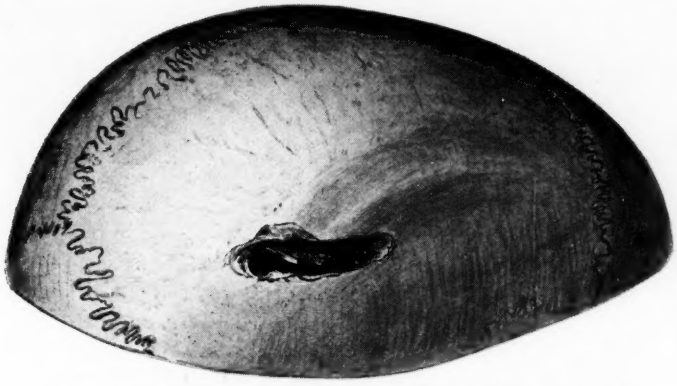


FIG. 452*a*.—No. 1.28. External surface of calvaria, showing an aperture in right parietal bone caused by a tangential blow, with depressed fragment in its floor. Note the marginal chipping at the posterior end of the aperture.

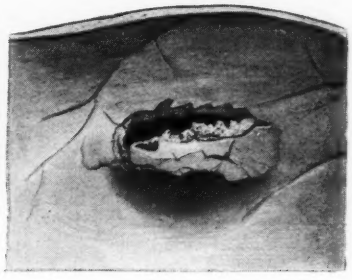


FIG. 452*b*.—No. 1.28. Internal view of the right parietal bone, showing the fragments fixed in position by healing.

has been carried away by the missile. The fragments of the calvaria are attached to one another and to the main portion of the bone at the posterior end of the aperture, and have become fixed in position by healing. On the cerebral aspect of the injured area there is evidence of a pachymeningitis. There is no fissuring of the calvaria except of the finest character, which is confined to the inner table at the posterior end of the aperture. No history of this specimen could be obtained.

Specimen No. 1.25 (*Fig.* 453) shows a similar lesion to the last, but more extensive in destruction results. There is a gunshot wound of the left parietal bone, causing an irregular gap 65 × 25 mm. The missile, probably a bullet, entered at the medial end of the aperture and emerged at its lateral end. There is undercutting of the medial margin at the point of impact, with a depressed fragment *in situ*. The lateral, posterior, and anterior margins are overcut, showing an external bevelling. From the gap four wide fissures radiate towards the base, two from each end, and it will be noted that they are arranged as in the so-called 'butterfly' type of fracture. The fissures are partially filled with new bone deposit, and the margins of the aperture also show signs of healing. No history of this case was obtained.

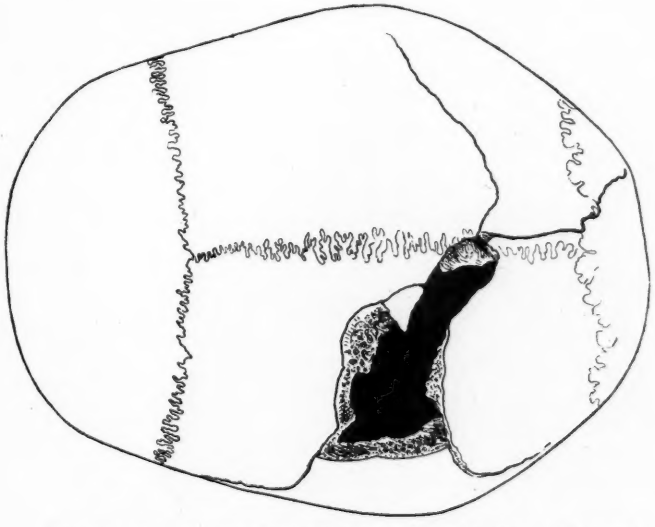


FIG. 453.—No. 1.25. Showing the effects of a tangential blow. The missile entered at the medial end of the aperture—almost on the sagittal suture—and carried away fragments from the lateral end.

Group 2.—Penetrating Injuries of the Cranial Cavity.

The Collection contains 33 specimens of penetrating wounds—injuries in which the missile becomes lodged within the cranial cavity. Penetrating injuries have been subdivided into two groups: (*a*) *Simple—those with no secondary injury from the same projectile*; (*b*) *Those with secondary injury, in which the projectile, having passed through one wall of the cranium, produced a secondary injury of another portion of the cranium.*

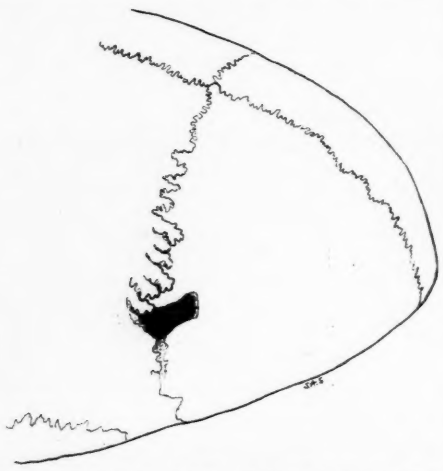


Fig. 454.—No. 1.143. External surface of the calvaria, showing a simple punctured wound of the right lateral surface of the frontal bone at the coronal suture. There are no marginal fissures. A median frontal suture is present.

a. **Simple Penetrating Injuries of the Cranium.**—The simple injuries naturally fall into two groups, one in which a clean aperture in the wall is formed without fissuring; and a second where fissuring and explosive effects are seen. There are 14 specimens which show simple penetrating injury with no fissuring of the surrounding bone, 3 being of the frontal, 4 of the parietal, 5 of the temporal, and 2 of the occipital bone.

Specimen No. 1.143 (*Fig.* 454) is an example of this class. There is a rectangular aperture in the right lateral portion of the frontal bone, just on the coronal suture. The injury was evidently produced by a shell fragment which penetrated the brain. The aperture is clean-cut, and there is no fissuring. No history of this case is obtainable.

There are 12 specimens of simple penetrating injuries which show fissuring of the area of penetration, and in many cases other disruptive or explosive effects. Specimen No. 1.2115 (*Fig.* 455) is a cranium with a gunshot

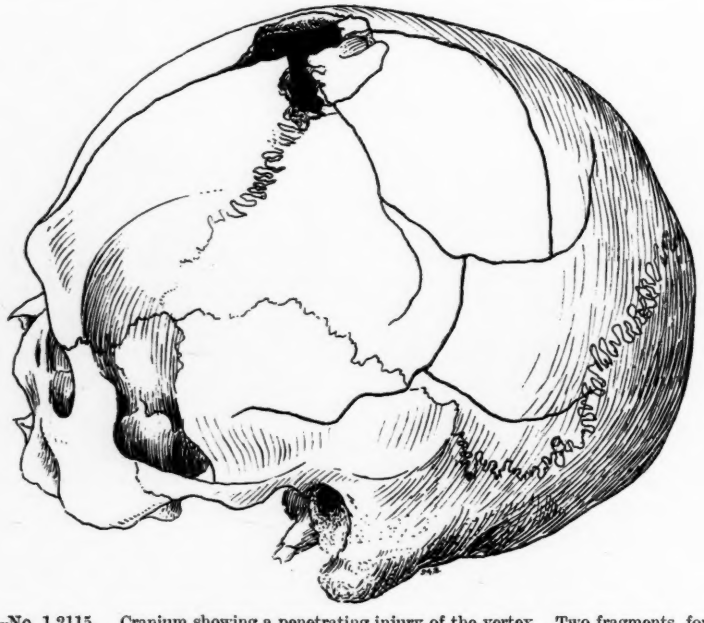


Fig. 455.—No. 1.2115. Cranium showing a penetrating injury of the vertex. Two fragments, forming the posterior margin of the aperture, are depressed.

fracture in the bregmatic region of the vertex, producing an irregular aperture 27 × 27 mm., with extensive splintering of the left parietal and of the frontal bones. The

fracture of the frontal extends to, and involves, the inner wall of the right orbit and right maxillary bone. Two bone fragments forming the posterior margin of the aperture are depressed. An extensive inverted Y fissure passes backwards and downwards to the squamous portion of the left temporal bone. The soldier was wounded Nov. 27, 1918, and died in a casualty clearing station thirty hours later. At autopsy, a shell fragment (copper driving band), $1 \times 1 \times \frac{1}{2}$ cm. in size, and pieces of indriven bone, were found embedded in the cortex of the left hemisphere. The surrounding brain substance was markedly lacerated, and there was extensive subdural hæmorrhage over the left parietal, frontal, and temporal lobes.

b. **Penetrating Injuries of the Calvaria with Secondary Injury to another portion of the Cranium.**—This is a small set of 5 specimens, 4 of which show partial penetration of the opposite wall of the cranium, and 1 of which shows an internal ricochet of the missile on the opposite wall of the cranium. Specimen No. 1.165 (*Fig.* 456) shows an extensive right frontal and left parietal type of injury caused by a piece of shell-casing. The projectile entered above the right frontal eminence, producing a crescent-shaped aperture, 35 × 10 mm., with a single fissure descending towards the right orbit. The missile became arrested in the aperture of exit in the left parietal bone near the ventral end of the coronal suture. This aperture is circular, 25 mm. in diameter. The specimen shows a fragment of bone *in situ*, with the missile fixed in the aperture. The soldier was wounded on May 12, 1917. He developed a cerebral hernia, with aphasia, and facial convulsions. He died May 27. Meningitis with cerebral abscess was found at autopsy.

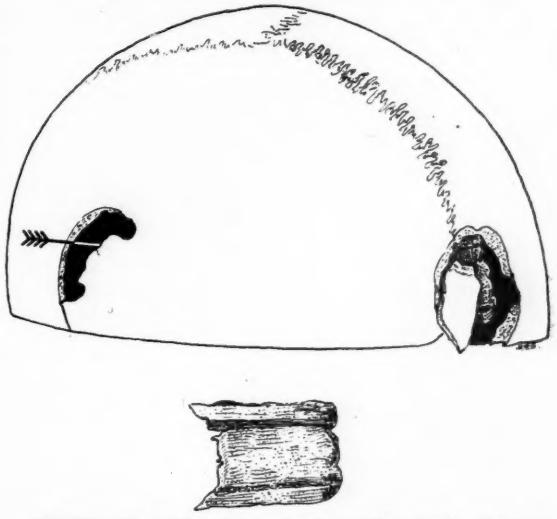


FIG. 456.—No. 1.165. External surface of the calvaria, showing crescent-shaped aperture of entrance, and an aperture in left parietal bone at the ventral end of the coronal suture, over the right frontal eminence, in which can be seen the piece of shell-casing and a loose bone fragment. The piece of shell-casing is represented below, half natural size.

Specimen No. 1.134 (*Figs.* 457*a*, 457*b*) is a calvaria with a large shell fragment, 43 × 10 mm., lodged in the right half of the frontal bone. The missile grazed the right shoulder, and entered the base of the skull from behind the right ear. It passed through the brain, and, perforating the frontal bone, became lodged in the aperture. About one

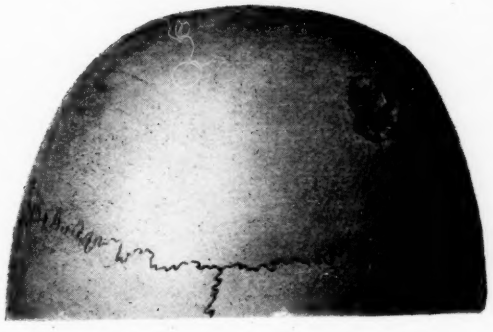


FIG. 457*a*.—No. 1.134. External surface of calvaria, showing an internal punctured wound of the right side of the frontal bone, with the missile, a shell fragment, lodged in the aperture.

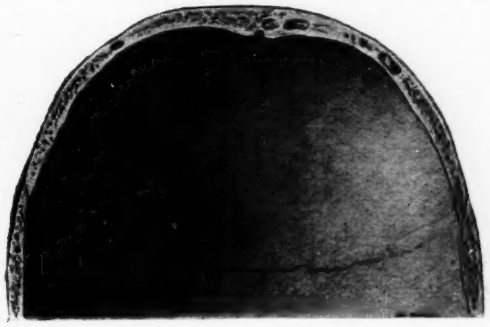


FIG. 457*b*.—No. 1.134. Internal surface of calvaria, showing the portion of the missile within the interior of the cranium.

quarter of the missile extends beyond the margin of the aperture, which is 8 mm. in diameter, and shows external marginal bevelling but no fissuring. The soldier was wounded on Sept. 6, 1917, and died twenty-four hours later. The portion of the base of the cranium showing the aperture of extrance of the missile has not been preserved.

Group 3.—Perforating Injuries of the Cranium.

A perforating injury may be defined as that type in which the missile passes through two walls of the cranium and produces a wound of entrance and a wound of exit. In the Collection there are 22 specimens showing perforating injury. We have employed the following nomenclature to indicate their nature: bifrontal, biparietal, frontoparietal, fronto-occipital, parietofrontal, etc., the first-named bone indicating the site of the entrance aperture, the second that of the aperture of exit. The lesions were distributed as follows:—

Bifrontal	.. ..	5
Frontoparietal	.. ..	1
Palato-occipital	.. ..	1
Occipitofrontal	.. ..	1
Parietofrontal	.. ..	2
Parieto-orbital	.. ..	1
Biparietal	.. ..	6
Temporoparietal	.. ..	1
Bi-occipital	.. ..	1
Occipitoparietal	.. ..	0
Temporo-occipital	.. ..	1
Temporo-orbital	.. ..	2
Total	..	22

Specimen No. 1.234 (*Fig.* 458) is an example of parieto-frontal injury. The missile, a bullet, entered near the posterior superior angle of the left parietal bone, and emerged below the left frontal eminence. The aperture of entrance is circular, 8 mm. in diameter, with marginal fracture of the outer table. The aperture of exit is irregular in shape, 28 × 12 mm., and surrounded by an oval area which is extensively fractured, and demarcated by a fissure. A gaping fissure commencing at the aperture of entrance ends in the oval fissure surrounding the area of exit. A linear fissure crosses the forehead for some distance from the wound of exit. No history of this case was obtained.

FIG. 458.—No. 1.234. Lateral view of calvaria, showing the apertures of entrance and exit in a case of bullet wound. An extensive oval area of fracturing surrounds the aperture of exit, and a gaping fissure joins the two apertures.

FIG. 459.—No. 1.252. Posterolateral view of calvaria, showing a biparietal or parietotemporoparietal perforating injury. The aperture of entrance is sharply punched.

Specimen No. 1.252 (*Fig.* 459) differs from the specimens already described, in that the wound of entrance, near the posterior superior angle of the left parietal bone, is a clean-cut puncture, 8 mm. in diameter, with no shattering of the surrounding bone, and only one short fissure extending inwards and forwards from its anterior margin. The aperture of exit in the right parietosquamosal region is large, and irregular in shape. There is

considerable shattering of the margins of aperture, with numerous radiating fissures. No history of this case is available.

Specimen No. 1.1605 (*Fig.* 460) shows the effects of a bifrontal perforating injury. The missile, apparently a bullet, entered in front of and near the mid-point of the right coronal suture, and emerged above the left angular process of the frontal bone. The frontal bone is thick, 8–9 mm., and the bullet, entering and emerging at a tangent to the plane of the bone, has caused rugged apertures at its points of entrance and emergence. There is an extensive series of fissures ; one joins the apertures of entrance and exit, while the others radiate out from these apertures—particularly that of emergence. From each aperture a fissure descends on the forehead, and involves the orbital plates. One spreads backwards on the roof of the skull from each aperture. A fissure passing backwards on the left side above the level of the zygoma tends to separate the basal from the upper part of the skull. An isolated fissure crosses the floor of the left cerebellar fossa. No notes could be obtained of this specimen.

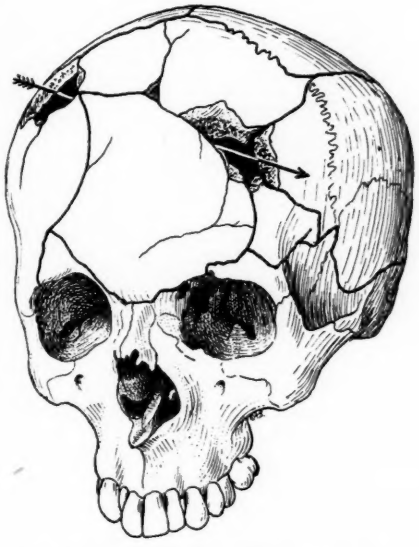


FIG. 460.—No. 1.1605. Cranium, showing extensive fracturing following a bifrontal perforating injury caused by a bullet.

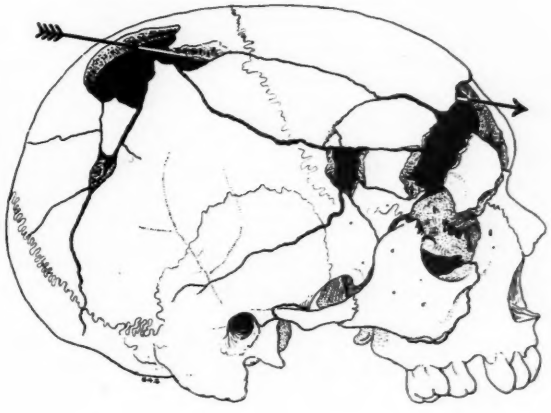


FIG. 461.—No. 1.235. Lateral view of calvaria, showing an extensive perforating parietofrontal injury.

Specimen No. 1.235 (*Fig.* 461) shows a very severe parietofrontal injury. The missile, probably a fragment of shell, entered above the right parietal eminence, and emerged on the forehead above the root of the nose. The apertures of entrance and exit are large, irregular, and connected by a series of fissures. From the aperture of entrance, fissures extend downwards to the lambdoid suture on the right side. There is marked comminution of the frontal bone surrounding the aperture of exit, with loss of the orbital plate of the frontal bone. Numerous fissures extend into the base from the aperture. The soldier was wounded on Nov. 16, 1917, and died four hours after admission to hospital. At autopsy, the whole of the right frontal lobe was found to be pulped.

Specimen No. 1.8231 (*Fig.* 462) shows a temporo-occipital perforating injury. The missile, probably a bullet, entered 15 mm. above the right auditory meatus, and made an exit in the supra-occipital region, 35 mm. above and to the left of the external occipital protuberance, and therefore involved the pole of the left cerebral hemisphere. The soldier, a German, was brought into No. 3 General Hospital on Sept. 7, 1918, deeply unconscious. The wound of entrance was explored and widened by operation (the aperture in the skull now measures 40 × 37 mm.) ; diffluent brain, soaked with greenish pus, escaped. The wound of exit was also explored, and the loose pieces of bone (now replaced

in the specimen, and indicated by stippling) were removed. The patient died soon after the operation. The specimen illustrates the 'explosive effects' which attend complete penetration of the skull, the occipital sutures in this case being wrenched open, besides producing fissures above and below the track of the missile.

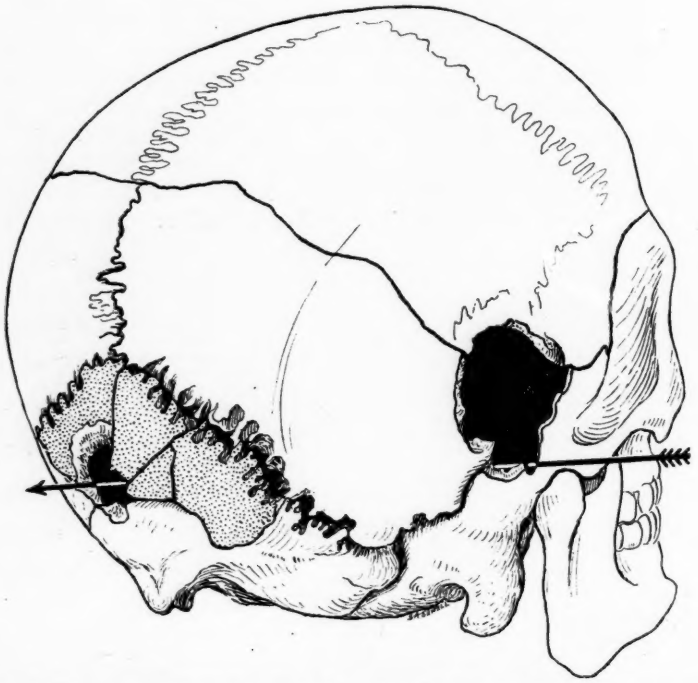


FIG. 462.—No. 1.8231. Posterolateral view of skull, in which the occipital sutures have been wrenched open by a perforating tempor-ooccipital wound. The fragments shown by stippling were found loose, but have been replaced. There has been an explosive force which has caused extensive fissuring of the cranial chamber.

A study of specimens showing through-and-through perforating injuries of the calvaria indicates several points of marked interest. The aperture of entrance is smaller than the aperture of exit. Also the latter shows, as a rule, more marked fracturing of the surrounding bone. The apertures of entrance and exit, no matter how widely separated, are usually connected by a fissure, which is often gaping.

SPECIMENS IN WHICH A TREPHINING OR DECOMPRESSION OPERATION HAS BEEN PERFORMED.

There are 26 specimens in the War Office Collection in which an operation of the above kind has been performed.

Specimen No. 1.1783 (*Fig.* 463) is part of a calvaria showing a trephined, irregular aperture, 30 × 30 mm., in the frontal bone above and to the right of the right frontal eminence. The superior margin is circular, produced by a trephine drill, while the inferior margin has apparently been enlarged by the use of bone forceps. From the aperture a fissure crosses the coronal suture and, 25 mm. beyond that suture, divides into two diverging limbs. Another fissure descends towards the right orbit. The clinical history of this case is not obtainable.

Specimen No. 1.176 (*Fig.* 464) illustrates in a remarkable manner the extent of bone which may be damaged in massive contused injuries, and the radical nature of the resection which may be undertaken by the surgeon in its treatment. There is a hole in the frontal bone measuring 100 × 100 mm., representing the major portion of the body of the bone, and extending from the supra-orbital margin to the bregma. Apparently the frontal bone was struck by a fragment of shell. The soldier was wounded on April 3,

918, and a wide decompression operation was performed three days later. The frontal bone was badly shattered, with a large extradural clot, and bone fragments were removed, producing the aperture described above. He died the next day.

Two specimens described under previous headings, No. 2.444 (*Figs.* 451*a*, 451*b*) and No. 1.1832 (*Fig.* 462), are from cases in which a trephine operation had been done. In specimen No. 1.85 (*Fig.* 467) also it would seem that such an operation had been carried out. *Figs.* 449*a*, 449*b* also show large areas removed by trephining.

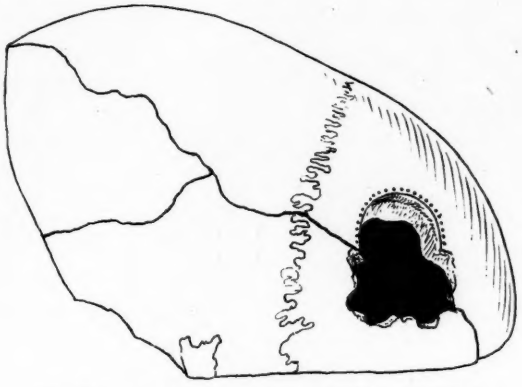


FIG. 463.—No. 1.1783. Showing a trephine aperture of the right frontal bone.

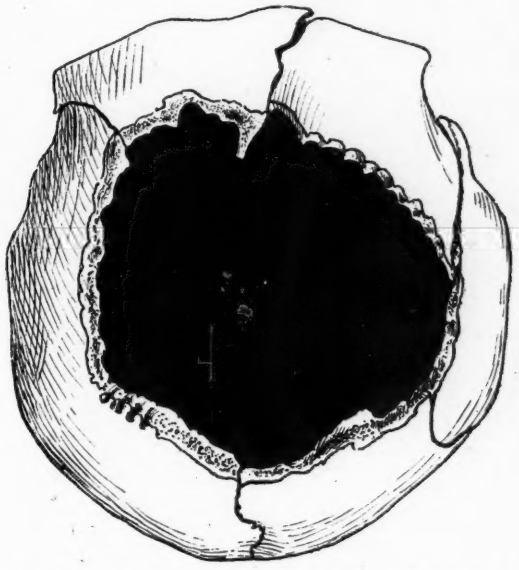


FIG. 464.—No. 1.176. Calvaria, showing almost the whole of the tabular part of the frontal bone removed by operation.

SPECIMENS OF CRANIA SHOWING VARIOUS REPARATIVE PROCESSES.

In the War Office Collection 16 specimens show evidence of various stages of healing. In two of these a definite history is available in which the injury had occurred one year before death.

Specimen No. 1.22 (*Fig.* 465) is the calvaria of a soldier showing the extent of the healing process a year after infliction of the wound. There is a perforating frontoparietal injury. The aperture of entrance is circular, 4 cm. in diameter, and lies partly in the frontal bone and partly in the left parietal bone, with the equator along the line of the coronal suture. It has been enlarged, and its posterior margin shows a narrow crescentic-shaped sequestrum entirely separated. The lateral and anterior margins are smooth and rounded by absorption. The medial margin is irregular, moth-eaten in appearance, and along the coronal suture, medially for about 2 cm., there is an area of the frontal bone showing granulation excavation. A second sequestrum

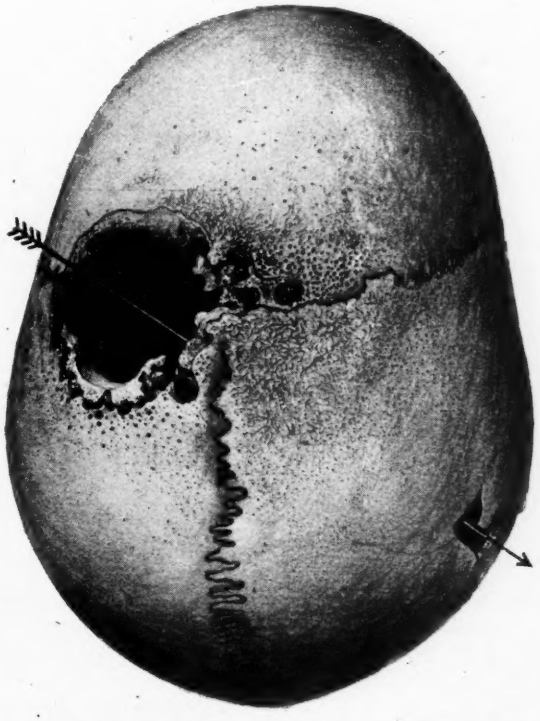


FIG 465.—No. 1.22. Calvaria, showing the condition of a frontoparietal gunshot wound a year after infliction. Marginal sequestra are shown at the aperture of entrance, a result of chronic infection and suppuration.

lies against this margin in front of the sagittal suture, but separated from the surrounding bone. The surface of the external table of the surrounding areas of the calvaria is

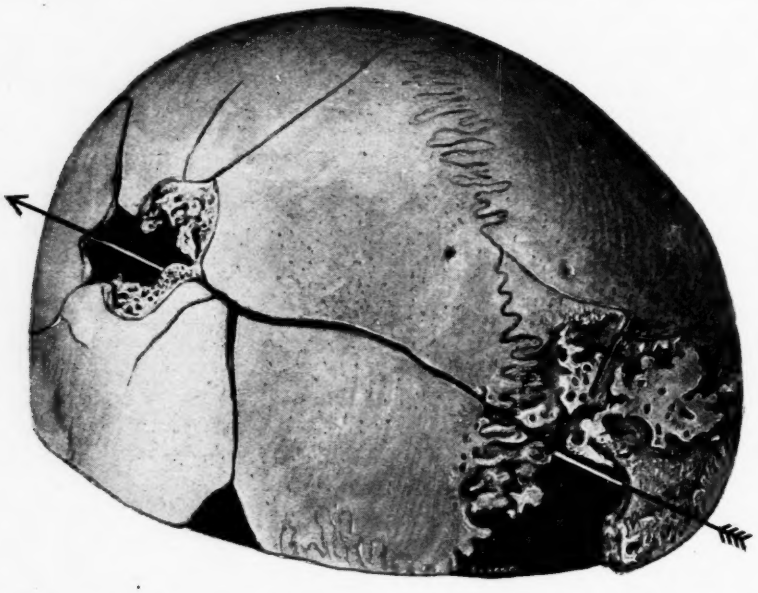


FIG. 466.—No. 1.251. Calvaria, showing early attempt at repair, particularly about the aperture of entrance. The arrow indicates the direction of the missile.

roughened, and fine callus points can be seen. The aperture of exit lies at the right parietal eminence. It is irregular in shape (17 × 33 mm.), and from it radiate three

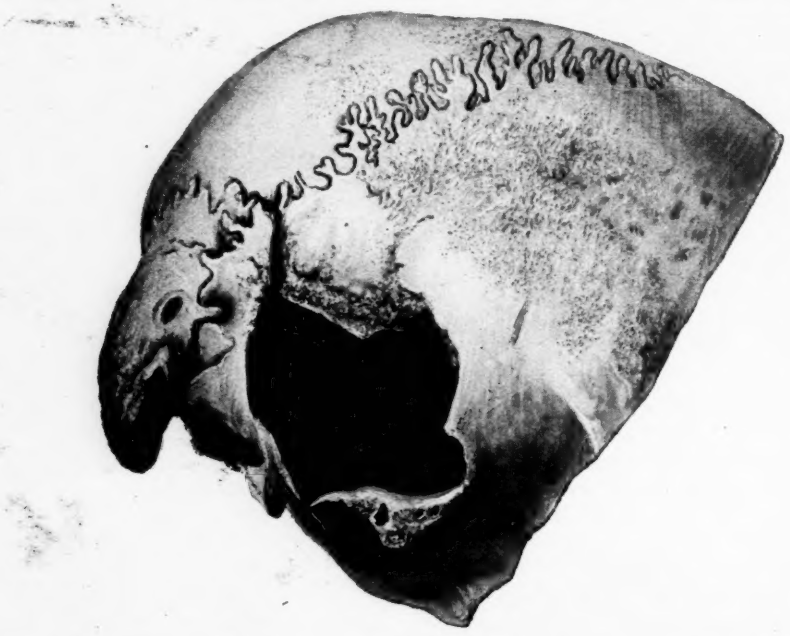


FIG. 467.—No. 1.85. Left occipital region of the skull, showing a large aperture with healed margin.

fissures which, although still clearly indicated, have been closed by bone deposition. The margins of the aperture of exit are smooth and thinned out, and a fragment has become

healed to the anterior margin. No clinical history of this case is available, other than that the injury occurred one year before the date of death.

Specimen No. 1.251 (*Fig.* 466) is that of an oblique biparietal gunshot wound. The aperture of entrance is situated near the posterosuperior angle of the right parietal bone ; the aperture of exit below the left parietal eminence. The openings are connected by a gaping fissure, and from the aperture of exit numerous fissures radiate. One, widely open, passes to the left orbit ; another into the temporal fossa ; and a third towards the sagittal suture. The areas of bone between these fissures are somewhat elevated, indicating the 'explosive' effects of a perforating wound. The area of bone surrounding the aperture of entrance shows superficial exfoliation, the cortex having a moth-eaten appearance, due apparently to pyogenic erosion following elevation of the periosteum. The external margin of the aperture of exit is splintered, and part has been carried away. The exposed diploe is broken down and eroded.

Specimen No. 1.85 (*Fig.* 467) shows the process of healing completed. There is an oval aperture in the nuchal part of the occipital bone, 35 × 23 mm. in diameter, evidently caused by a gunshot wound received several months before death. The edges of the aperture are everted, smooth, and have been thinned out and rounded by absorption, no callus having been laid down. A short wide fissure, 2 cm. long, extends downwards from the aperture. The clinical history of this case could not be obtained.

Specimen No. 1.1605 (*Figs.* 468*a*, 468*b*) shows a bifrontal injury of the cranium, with an extensive series of fissures. The particularly interesting feature of this specimen is that it represents a completely healed depressed fracture of the right parietal bone. The area of depression measures 60 × 50 mm., and in extent and appearance suggests that it may

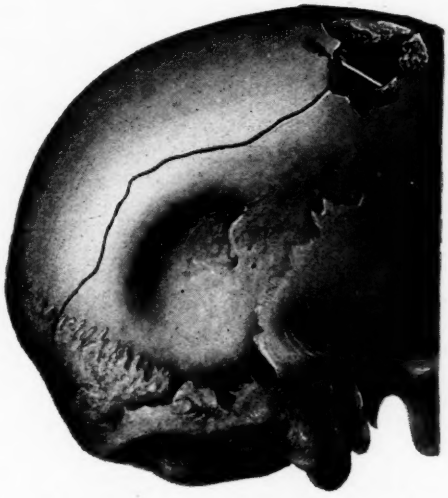


FIG. 468*a*.—No. 1.1605. External surface of calvaria, presenting the entrance aperture of a recent and fatal bifrontal injury, and a crescentic depressed area near the postero-inferior angle of the right parietal bone, the result of an old and healed depressed fracture.

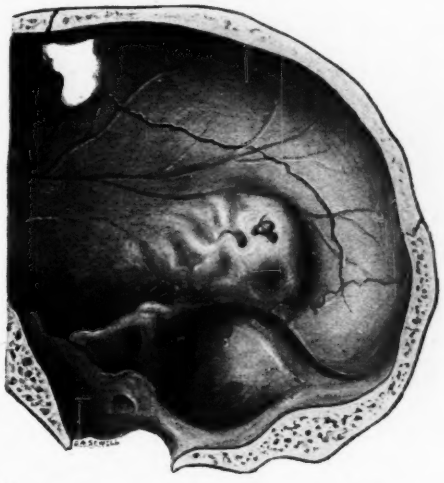


FIG. 468*b*.—No. 1.1605. Internal surface of same specimen, showing the condition of the depressed area. It lay over the posterior ends of the first and second temporal convolutions. The man was passed for general service.

have been caused by a severe accident—such as a kick from a horse. We estimate that the bone was driven inwards to a depth of 4 mm. On the inner aspect of the skull is seen a correspondingly raised area lying over the posterior or occipital ends of the first and second temporal convolutions. Although we have not ascertained either the manner or time of the accident which produced this unrelieved depressed fracture, there is no doubt that the functional result was good, for the man was passed for general service, and died when taking part in arduous fighting. The line of fracture is almost obliterated by bony union ; only at certain points can it be traced by the presence of a series of vascular

foramina. The severity of the injury, the completeness of the recovery, and the obliteration of the line of fracture by bony union, make this specimen worthy of being placed on record.

A study of the specimens in the Collection showing a healing process brings out certain interesting features. It is not possible to enter into a discussion of the various views held concerning new bone formation and the repair of cranial injuries. One school has emphasized the importance of the periosteum in bone repair, and another the value of cancellous bone. In these specimens the separation of dead bone fragments and areas of infected bone by a process of sequestration can be readily traced, but in every case the amount of callus formation is scanty. In older specimens, fragments are cemented in place by internal callus. Gaping fissures become filled and obliterated. These points would serve to show that evidently, in the cranial bones at least, the cancellous bone is the only part capable of producing callus. To a limited extent this is due to the small area of cancellous tissue present. In old apertures one finds a process of absorption going on at the margins. They become thinned out and smoothed ; but none of the specimens n the collection show any attempt to bridge over the defect, even after an interval of a year. It is of interest to note that the trephine may so injure the bony margin of the aperture that the marginal area dies and is separated before the aperture undergoes a fibrous closure.

Section II.—ATYPICAL INJURIES OF THE CRANIUM.

In the War Office Collection there are specimens which illustrate the accidents as well as the wounds of warfare. One of the most remarkable of these accident specimens is No. 1.901, the skull depicted in *Figs.* 469*a*, *b*, *c*, and *d*. A soldier, while felling timber in France, had the misfortune to be caught by a falling trunk, by which his head was crushed. He was already dead when brought into No. 9 General Hospital, with blood escaping from his ears, nostrils, and mouth. The brain was found to be lacerated, and

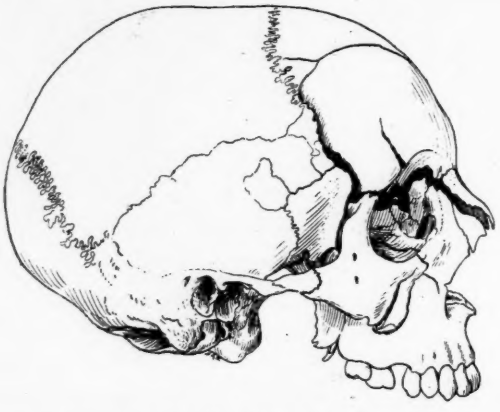


FIG. 469*a*.—No. 1.901. Right lateral aspect of skull, showing a series of fissures in the right fronto-sphenoidal region, extending into the regions of the orbit, nose, and cheek—the result of a crushing accident.

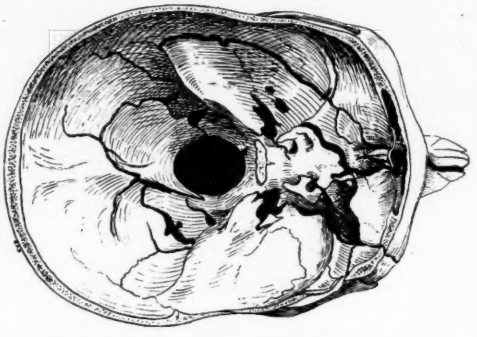


FIG. 469*b*.—No. 1.901. The base of the specimen depicted in *Fig.* 469*a*, showing a series of longitudinal fissures extending along the interior of the cranial floor.

the seat of extensive hæmorrhages, particularly on its basal aspect. The skull gives a vivid representation of the results of a crushing accident—one which tends to flatten the head from side to side. We note that the base of the skull has suffered most ; *Figs.* 469*b* and *d* show a complex of fractural lines, chiefly arranged in an anteroposterior direction, showing that the base of the skull is less able to withstand a crushing force —acting from side to side—than is the vertex or calvarial region, which in this case has escaped with minor damage. The temporal bones, forming solid triangular wedges, have been forced into the base, the thinner bone in the floor of the cerebellar fossa suffering

the greatest amount of damage. The crushing force was applied, apparently, in the region of the left mastoid, while the region of the right forehead and cheek became the chief fulcrum or region of resistance. As may be seen in *Fig.* 469*a*, the disrupting force has fallen on the right fronto-malar region, with the result that the malar and the adjoining part of the frontal bone have been driven inwards, tending to separate these parts from the rest of the skull. The right coronal suture has sprung open in part (*Fig.* 469*a*); so has the spheno-malar suture. The manner in which a lateral compressing force affects the face is shown with a diagrammatic distinctness in *Fig.* 469*c*. The malar bones have been driven towards each other, and have crushed the thin-walled maxillary supports interposed between them. The inter-orbital, infra-orbital, and nasal regions have been extensively fissured.

We requested Mr. Sewell to give particular pains to the palate of the specimen shown in *Fig.* 469*d*—not only to show the lines of fracture, but to show the contracted condition of the palate, which may be noted in fully 50 per cent of our soldiers. Such a condition is never seen in British skulls until the eighteenth century. Not only is the palate narrow, and high vaulted, but there is a lack of strength in the bones of the face, and often of the whole skull, as if there had been a defective deposition of bone during the age of body growth.

FIG. 469*c*.—No. 1.901. Facial aspect of the skull shown in *Fig.* 469*a*. The parts of the face interposed between the malar bones have been crushed by a compressing force acting from side to side.

FIG. 469*d*.—No. 1.901. The outer basal aspect of the skull shown in *Fig.* 469*a*, showing the lines of fracture resulting from a compressing force. The palate shows a condition to be seen in 50 per cent of British soldiers.

In *Fig.* 470 we reproduce a series of sketches taken from specimen No. 1.253. The specimen itself is represented by the central drawing in the figure. The interior of that part of a skull which is formed by the upper part of the occipital bone and hinder part of the parietal is there depicted; the arrow shows the course of a shrapnel ball which has pierced above and behind the left ear, and, after traversing the brain, has come to rest beneath the scalp on the right side of the head. It is clear, from the fact that the ball had not sufficient momentum to escape from the soft parts which covered the right side of the head, that in making this through-and-through wound it had already lost its maximum velocity, yet it has drilled very clean holes in the bone. The apertures of entrance on both sides of the skull (*a*, *c*) are cleanly-cut round holes, (*c*) being slightly larger than (*a*), while the apertures of exit show external bevelling, which affects the internal table in the one case (*b*) and the external table in the other (*d*). The degree of destructive bevelling is greater in (*d*) than in (*b*), but it is plain that this result is not due to a difference in the texture of

the tables, but to a decrease in the velocity of the ball. The missile shows no appreciable flattening. The subject of this perforating (through-and-through) wound was a gunner, who died three hours after the infliction of the wound. There was no 'explosive' effect apparent in either skull or brain. (Compare with the case of shrapnel-ball fracture shown in *Fig.* 478.)

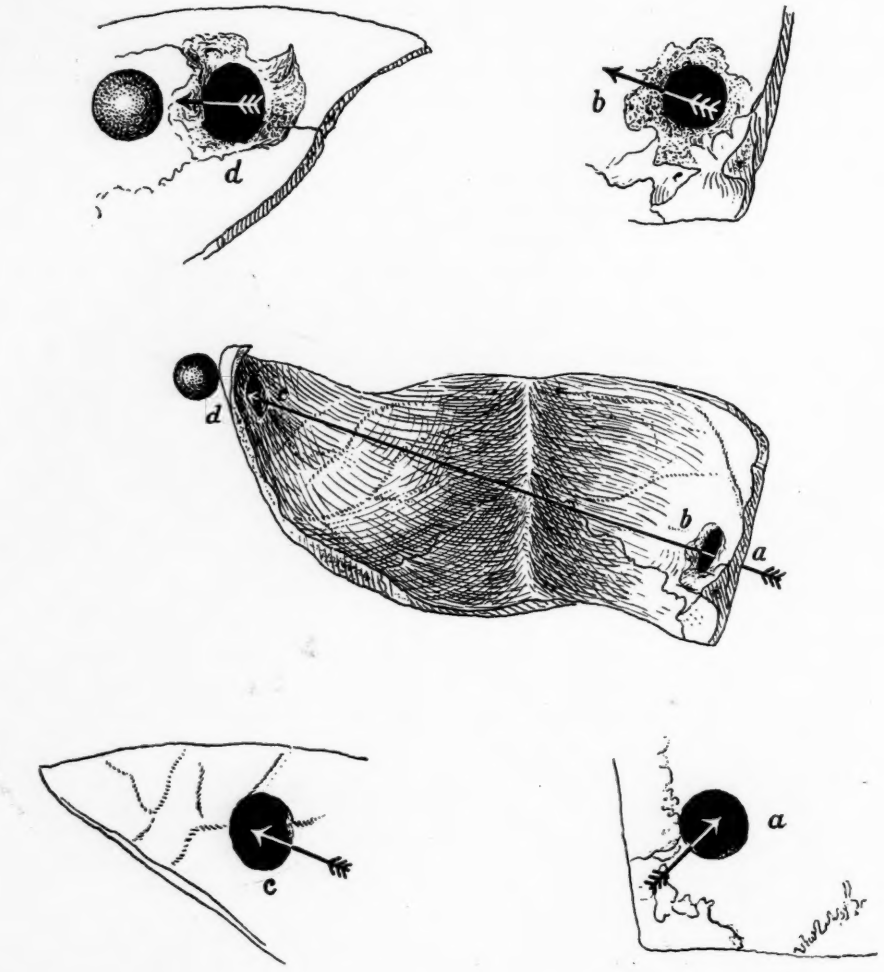


FIG. 470.—No 1.253. A series of sketches to show the entrance and exit apertures caused by a shrapnel ball which was arrested in the tissues of the scalp at the wound of exit. The central sketch shows the track of the missile in the parieto-occipital region of the skull. The adjoining sketches show the apertures of entrance and exit on both sides of the skull.

In *Figs.* 471*a*, 471*b* we represent the skull (No. 1.023) which illustrates better than any other in the Collection the disruptive or 'explosive' effects which result from missiles of high velocity fired at close range. In this case the wound was self-inflicted—a revolver of a service pattern being fired so that the bullet entered the mouth, pierced the base of the skull, and made its exit in the region of the left parietal eminence. The palate and the walls of the nasal cavity have been comminuted, but the most remarkable effects are to be seen in the region of the exit wound (*Fig.* 471*b*). The missile comminuted and carried away the bone lying in its immediate track, thus leaving a large aperture of exit. Surrounding the aperture of exit is an irregular circle of large fragments, detached and raised up by the force of the missile. From the fragmented circle surrounding the

aperture of exit there pass forwards on the left side of the skull a double series of fissures which really join the aperture of exit in the left parietal region to the entrance wound in the region of the mouth. The missile, as it were, during its passage through the head, tended to lift up or blow out the left side of the skull, because its course lay closer to the surface of that side, which was consequently the less resisting. Thus we have in this specimen simply an exaggeration of the effects seen in every through-and-through wound of the skull—a tendency for the apertures of entrance and exit to be joined by one or more fissures, and for a circular area of bone surrounding the aperture of exit to be raised up and broken into a series of fragments. It is unnecessary to add that death was instantaneous in the case just narrated.

FIG. 471*a*.—No. 1.023. Lateral aspect of skull, showing destructive (explosive) effects following a missile of high velocity fired at close range. The arrow shows the course of the missile—a revolver bullet.

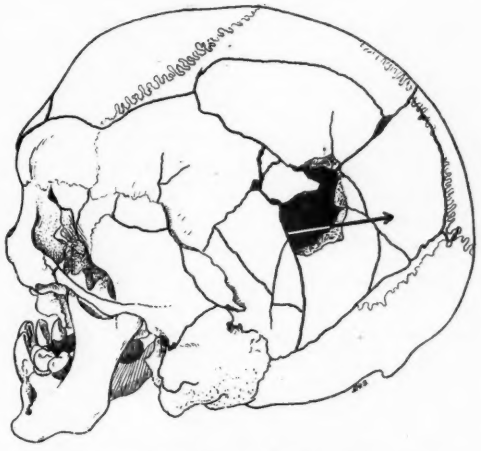


FIG. 471*b*.—No. 1.023. The aperture of exit, surrounded by a circle of large fragments of the left parietal. The course of the missile is shown in *Fig.* 471*a*.

Another specimen (No. 1.163) which illustrates the disruptive effects which attend a through-and-through wound is shown in *Fig.* 472. The missile, a fragment of shell, entered the left temporal region, severing the zygoma, and then pierced the cranial cavity behind the left angular process of the frontal, at the site of the middle meningeal vessels and third frontal convolution. Pursuing its oblique course through the frontal lobe, the missile escaped at the left frontal eminence, leaving behind it a ragged aperture of exit. The aperture has been enlarged by the removal of a loose fragment by the surgeon during an exploratory operation. The apertures of entrance and exit are joined by a fissure, while the whole region of the forehead surrounding the aperture of exit is broken by radiating and circular fissures. Beyond the immediate track of the missile, secondary effects are seen in the fracturing of the left maxilla (*Fig.* 472), and destruction of the interorbital septum and roof of the left orbit. The soldier who was the subject of this injury was admitted to hospital on Sept. 11, 1918; an exploratory operation was done the next day; and death from meningitis occurred on Sept. 16.

Extensive destructive effects may follow glancing or gutter wounds of the skull, as is shown by specimen No. 1.0221, depicted in *Fig.* 473. The soldier from whom this specimen was obtained was wounded on Dec. 5, 1917. He lay in hospital unconscious and pulseless for four days, with a horizontal lacerated wound in the left temporal region. Bone, blood, and brains were removed from the wound. Gas infection set in, and death occurred on Dec. 9. At the post-mortem examination, the left hemisphere of the brain was found diffluent and foul. No missile was found within the skull. The aperture

measures 52 × 20 mm., and is situated in the left parietal bone, just above and behind the squamous suture. Its edges are undercut except in two parts of the upper and lower

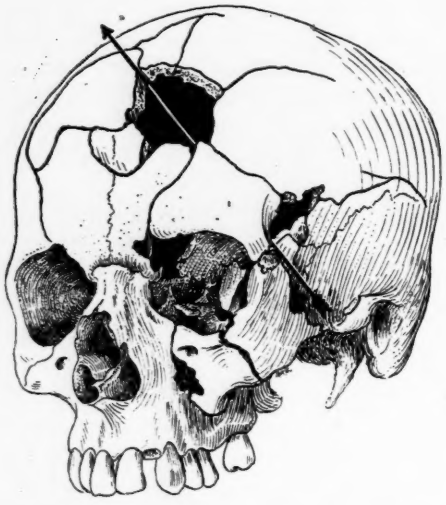


FIG. 472.—No. 1.163. A skull showing the disruptive effects of a through-and-through wound in the left frontal region. The course of the missile (a fragment of shell) is shown by the arrow.

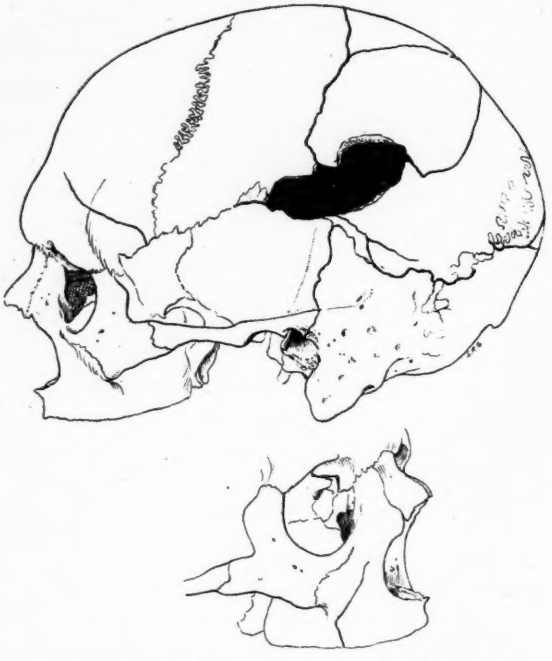


FIG. 473.—No. 1.0221. A skull showing extensive effects from a glancing or gutter wound in the left temporal region. The inset shows a remote vertical fissure of the right maxilla.

margins (*Fig.* 473). The missile, probably a bullet, struck a glancing blow, its course being from before backwards. Two fissures descend from the lower margin of the aperture, one to the lambdoid suture and occiput, another to enter the roof of the ear and base of the skull. From the upper margin a fissure ascends to the sagittal suture, while another passes backwards from the posterior end of the aperture.

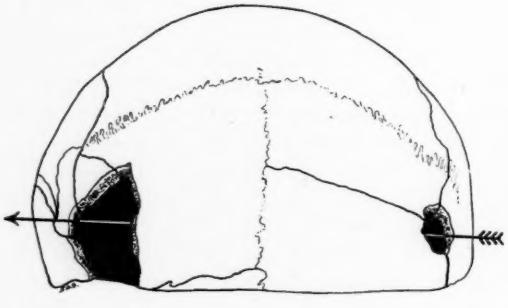


FIG. 474.—No. 1.1611. Frontal view of calvaria, showing a through-and-through wound, the missile—probably a bullet—passing in the direction of the arrow. A persistent metopic suture is shown.

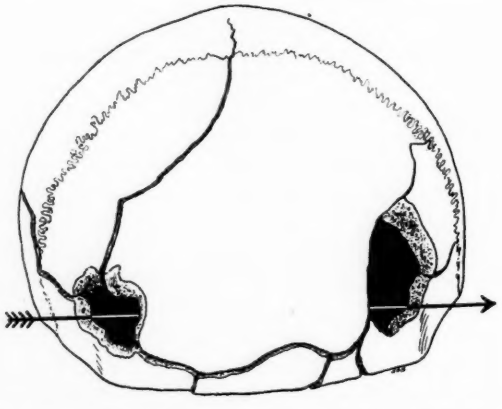


FIG. 475.—No. 1.1612. Frontal view of calvaria, showing a through-and-through wound in the frontal region, the direction of the missile being indicated by an arrow. Corresponding fissures are present in both specimens depicted in *Figs.* 474 and 475.

There are also remote or indirect effects seen in the vertical fissuring of the left maxilla, the fissuring of the roofs of both orbits, of the floor of the middle fossa, and of the left temporal area of the frontal bone.

The two specimens depicted in *Figs.* 474 and 475 illustrate bifrontal perforating (through-and-through) wounds, both proving rapidly fatal. In *Fig.* 474 (No. 1.1611) the missile, probably a bullet, entered above and lateral to the left frontal eminence, and made its exit at a corresponding point in the right temple. It will be noted there is a persistent interfrontal or metopic suture, and that the fissure which one expects to join the apertures of entrance and exit is really present, but is interrupted by the metopic suture. It will also be noted that from the aperture of entrance a fissure ascends towards the vertex, while another descends towards the left temporal region. The aperture of exit has been enlarged by the removal of a loose fragment. From the aperture a fissure passes backwards along the roof of the skull. In *Fig.* 475 (No. 1.1612) a wound very similar to the last described is shown, only the bullet traversed the forehead in a contrary direction, from right to left. In this case the aperture of entrance has been enlarged by the surgeon, while from the wound of exit a loose fragment has been taken away. In this instance the missile has traversed the head nearer to the frontal poles than in the specimen illustrated in *Fig.* 474, and hence the inter-apertural fissure is better marked, being gaping, and joined by secondary fissures. From the wound of entrance two fissures pass backwards, enclosing between them a triangular or *wing-shaped* area. Two minor fissures pass backwards from the aperture of exit.

In specimen No. 1.1621, which is shown in *Fig.* 476, the effects of a through-and-through wound of a superficial nature—almost a glancing or gutter wound—are well illustrated. The missile, a bullet, entered near the middle of the forehead, and passed out on the right side of the skull in the line of the coronal suture. The projectile thus pursued an oblique course through the frontal lobe of the right hemisphere. The calvarial wall between the apertures has been lifted out and broken. The bone round the

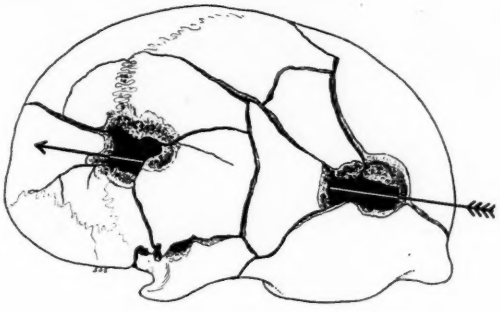


FIG. 476.—No. 1.1621. Shattering effects of an oblique and superficial through-and-through bullet wound. The missile entered in the mid-frontal region, and escaped at the right coronal suture.

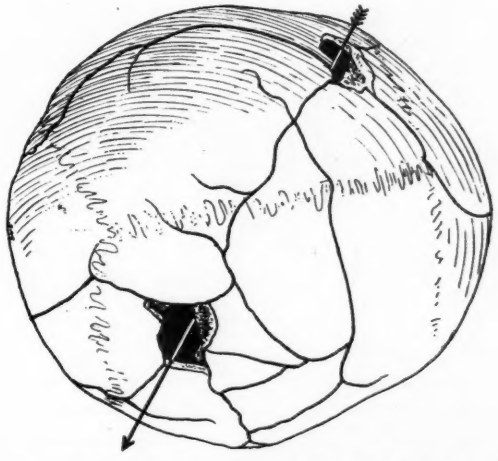


FIG. 477.—No. 1.2504. Showing the effects of a superficial oblique through-and-through wound in the vertex region of the skull. The direction of the missile is shown by an arrow from the left coronal region to above the right parietal eminence.

aperture of exit shows not only the usual radiating fissures, but also the irregular circular fissure which delimits the surrounding fragments, a form of injury already called attention to in connection with *Fig.* 471*b* and other illustrations. Although the fissures seen at the wound of entrance look, at first sight, as if they belonged to an irregular type, yet the usual arrangement is present. The two fissures which are seen to proceed from the wound of entrance towards the wound of exit, and enclose between them a triangular area, really represent the handle end of a racket-shaped fissure which usually surrounds an aperture of exit. The handle of this circular racket-shaped fissure represents the inter-apertural fissure. From the aperture of entrance two other fissures issue, and enclose

between them an area on which is situated the left frontal eminence. We see that these two fissures bounding the sides of a triangular area of bone are present at the point of impact of all missiles which impinge on the skull tangentially. In *Fig.* 477 (No. 1.2504), another superficial through-and-through wound is represented. In this case the missile has passed—as shown by an arrow—in an oblique direction across the vertex region of the calvaria, entering behind the left coronal suture, and passing out well above the right parietal eminence. There is seen the usual inter-apertural fissure, and a series of large fragments surrounding the aperture of exit which are partially delimited by a circular fissure. From the aperture of entrance pass out two fissures, in this case almost at right angles to the inter-apertural fissure, in place of being at a very obtuse angle to it. In both cases represented in *Figs.* 476 and 477 the wounds proved rapidly fatal.

In *Fig.* 470 we have represented the clean-cut perforations, with absence of fissuring, which usually attend the infliction of a through-and-through wound by a shrapnel ball. In *Fig.* 478 (No. 1.1613) is represented a somewhat similar case where a shrapnel ball entered the skull just behind the right external angular process of the frontal bone and made its exit above the left frontal eminence. The subject of this lesion was wounded at Camières, Oct. 7, 1915, and after a period of apparent recovery, died on Dec. 19, from an abscess in the right frontal lobe. The aperture of entrance shows a smooth marginal deposit of new

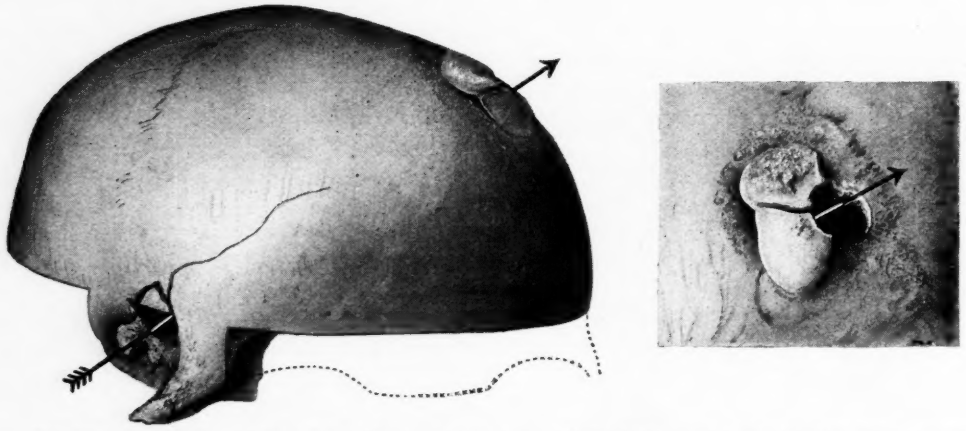


FIG. 478.—No. 1.1613. A bifrontal wound caused by a shrapnel ball which passed in the direction shown by the arrow. The inset shows the wound of exit. The soldier lived for two months after being wounded.

bone at its lower side and a fragment of detached bone at its upper side. There is an attempt at an inter-apertural fissure starting from the wound of entrance—which, by the way, shows marks of infection and suppuration. At the wound of exit there are two raised everted fragments which have become reunited to the skull at their bases by true bony union, but there has been no attempt to fill in the aperture by new bone. On the other hand, there are distinct signs of absorption in the outer table in the neighbourhood of the aperture of exit—an indication of suppuration.

In *Fig.* 479 (No. 1.022) we represent one of the most puzzling lesions to be found in the War Office Collection. The skull shown is that of a soldier admitted to No. 2 Canadian Casualty Clearing Station on March 8, 1917, with a gutter wound in the upper left parietal region of the head. The wound was excised and loose bone fragments were removed, but the patient died from acute encephalitis on March 13. From the oblong aperture in the left parietal bone a fissure passes forward to the frontal region, where it divides into two gaping branches, in the fork of which is a raised or everted triangle of bone. The appearance of this frontal fragment suggests that a missile which had entered the skull at the parietal aperture had passed forwards in the brain and struck the frontal bone, thus everting the triangular area. We presumed at one time that this had been the case, and hence we have inserted an arrow to represent the supposed direction of the missile. But a further

examination of the clinical notes, the absence of any missile from the frontal region, and the nature of the marginal bevelling shown by the parietal aperture, have convinced us that we are dealing here with a glancing or gutter wound—the missile entering at the

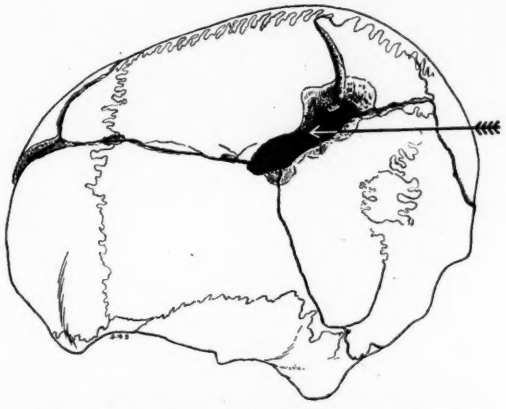


FIG. 479.—No. 1.022. A skull viewed on its left vertical aspect, showing an aperture caused by a glancing wound. The missile was probably a bullet which entered at the anterior and lower end and emerged at the upper and posterior end of the aperture. See text for fuller explanation.

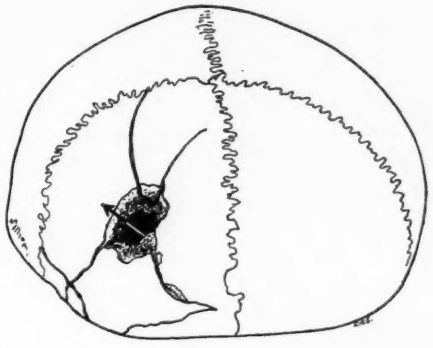


FIG. 480.—No. 1.1675. Frontal region of calvaria, showing the exit aperture of a bullet which entered the skull near the occiput and emerged at right angles to the plane of the frontal bone.

anterior end of the aperture, and emerging at its upper or posterior end. We have thus the usual V-shaped arrangement of fissures at the point of impact and point of emergence. Only in this case we are at a loss to explain the gaping Y-shaped fissure in the forehead, with the raised and everted area in the fork of the frontal fissure. We have set side-by-side with *Fig.* 479 an instance (*Fig.* 480) where a bullet has emerged from the skull, not tangentially as in *Fig.* 479, but at right angles to the cranial wall. In this specimen (No. 1.1675) the bullet entered at the occiput. The aperture of exit in the frontal bone is surrounded by radiating series of fissures. In this case death took place soon after the soldier was admitted to hospital.

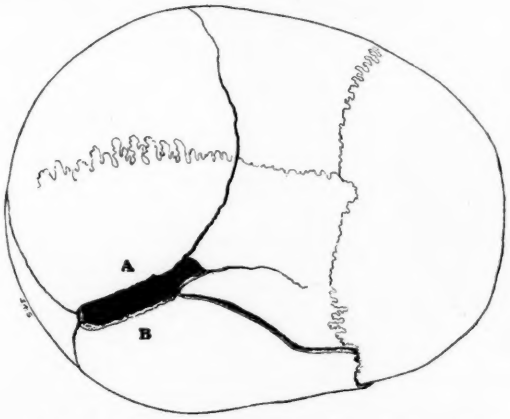


FIG. 481.—No. 1.2514. An oblong aperture in the right parietal bone caused by the graze of a bullet which entered at the lower and hinder end and emerged at the upper and anterior end. The specimen shows the typical arrangement of fissures which accompany such injuries.

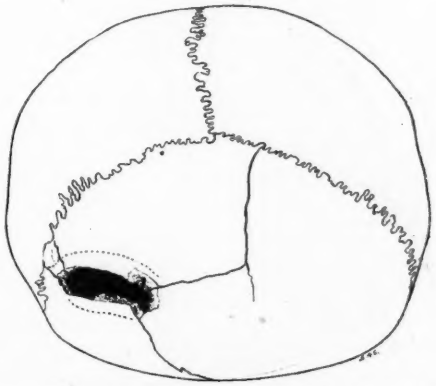


FIG. 482.—No. 1.1431. A tangential wound in the right frontal region. The stippled line indicates the area of undercutting.

In specimen No. 1.2514 we have a typical representation of the bony fissuring which follows a glancing impact of a bullet, but it was some time before we recognized the true nature of the type of injury represented by this specimen. In the absence of full clinical

details, we at first supposed that such an oblong aperture as is shown in the right parietal bone (*Fig.* 481) was caused by the penetration of a fragment of shell, and that the fissures which pass into the vertex, one from each angle of the aperture, were produced by the sharp corners of the penetrating missile. The true explanation of such a lesion as is shown in the figure is now beyond doubt, and is due to the glancing impact of a bullet, which in the present case has entered at the hinder and lower end of the aperture, and emerged at its upper, anterior, and more fragmented end. At the point of impact and entrance two fissures spread backwards, bounding a posterior triangular area ; while at the point of emergence two fissures, more extensive and more open, spread forwards. We do not offer here a physical explanation of this arrangement of fissuring ; we simply note that, in all tangential wounds of the skull, such a series of fissures as is shown in *Fig.* 481 can be identified. The missile tends to raise the bone on each side of its track as flaps or lids (*Fig.* 481 A, B).

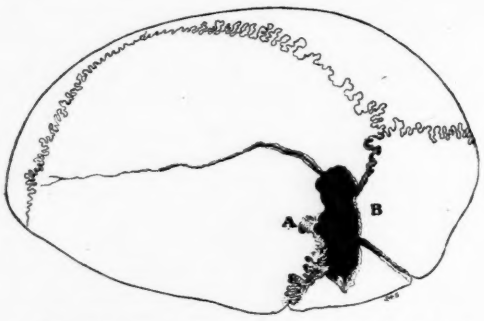


FIG. 483.—No. 1.291. A gutter wound in the left lambdoid region. The missile passed from the upper towards the lower end of the aperture.

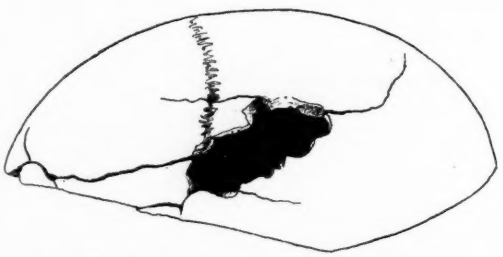


FIG. 484.—No. 1.254. A large and irregular aperture in the anterior and lower part of the left parietal bone—the result of a gutter fracture.

In *Fig.* 482 (No. 1.1431) a more limited aperture of the same nature as in *Fig.* 481, but in the right frontal region, is to be recognized. In this case the bullet came from the right and from behind, and glanced across the right frontal eminence. The stippled line round the aperture indicates the area from which the inner table has been detached —there being in this case much undercutting.

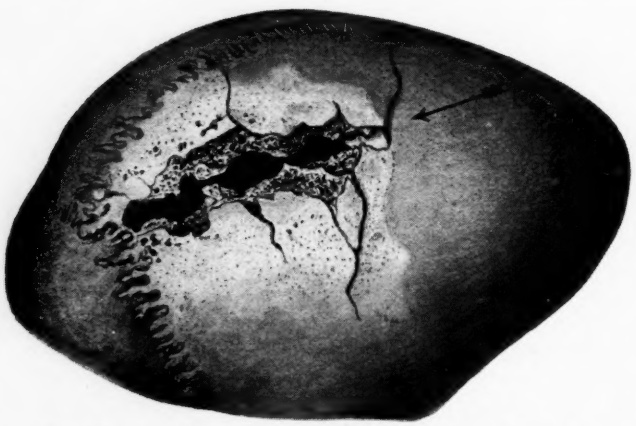


FIG. 485.—No. 1.285. A gutter wound of anomalous type in the upper and posterior part of the right parietal bone. The bone bounding the aperture is undergoing the changes which result from infection.

In *Fig.* 483 (No. 1.291) there is represented a gutter wound crossing the left lambdoidal suture obliquely from above downwards. The subject from whom this specimen was obtained was wounded by a fragment of high explosive on May 7, 1915, and died on June 11 of the same year. Brain matter extruded from the wound ; this was removed, and the wound enlarged in a downward direction. We have here the usual double-winged type of cranial gutter wound. From the upper end of the aperture—which we upposed to be the point of impact—two fissures spread out, one following the lambdoid suture, which in this case was still open, for the soldier was only 19 years of age. From this lower end of the original aperture two other fissures diverge, one following the lambdoid suture, the other passing down the occipital bone to reach the foramen magnum. In

this specimen we see the tendency of fissures to follow the line of unclosed sutures, and of the bone at each side of the aperture to be raised up as flaps or wings (*Fig.* 483 A, B).

In *Fig.* 484 (No. 1.254) an aperture is shown in the anterior inferior angle of the left parietal bone, measuring 50 × 20 mm. The soldier, a Newfoundlander, was struck on the left side of the head by a fragment of shell, April 25, 1917. Brain matter escaped; there was paralysis of the right limbs. Meningitis set in, and death followed on April 29 The arrangement of fissures is anomalous, particularly the gaping crack which runs down wards and forwards to the frontal region.

It is a misfortune that some of the more interesting specimens in the War Office Collection were obtained during the earlier phases of the War when full clinical notes could not be secured. One of these is shown in *Fig.* 485 (No. 1.285), the calvaria of a soldier who died from an abscess of the brain some weeks after being wounded. There is a gutter-like opening above the eminence of the right parietal bone. It is difficult to determine whether the missile passed along the gutter from before backwards, as is shown by the arrow, or in the reverse direction. There are no fissures connected with the posterior end of the aperture, nor is the lambdoid suture, which crosses it, at all opened. From the other end fissures proceed at right angles, and there is also a pair of fissures opposite the middle of the aperture. The bone in the neighbourhood of the aperture shows all the signs of infection. There is no attempt at the deposition of new bone; the bone seems to have necrosed for some distance beyond the roughened and porous margins of the wound. One notes that all the vascular foramina in the outer bony table near the wound have become enlarged.

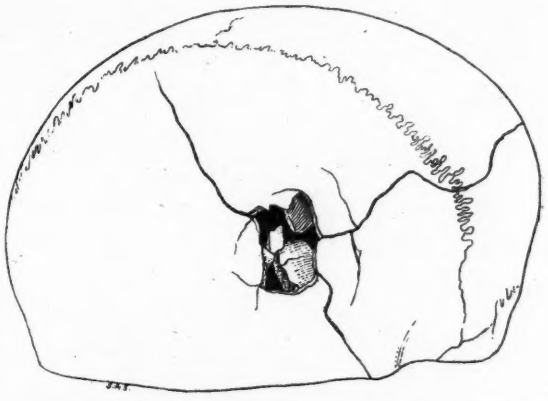


FIG. 486.—No. 1.142. Gutter wound in the left frontal region, with fragments driven inwards, causing laceration of the frontal lobe.

In *Fig.* 486 (No. 1.142) a glancing or tangential fracture of the frontal bone is depicted. The opening is 20 × 15 mm., showing within its floor the fragments of bone which were driven inwards by the missile. In this case a fragment of shell simply grazed the forehead. When one looks along the contour of the frontal bone, and notes the margins of the gutter, it is plain that the missile did not plough into the bone to a greater depth than perhaps one millimetre, and yet the impact has been sufficient to drive the fragments inwards. Whether the dura mater was ruptured or not there is no clear record, but a note has been made at the post-mortem examination that the frontal lobe was lacerated. The soldier was wounded by fragments of high explosive on June 7, 1917, and died on June 10. It will be noted that while two fissures diverge from the upper end of the frontal aperture, as is usual in glancing wounds of the cranium, at the lower end one of the fissures is indicated by a mere vestige.

Figs. 487*a*, 487*b* are drawn from specimen No. 1.2011, where death resulted from the detachment of an area of the inner table which was situated over terminal branches of the middle meningeal vessels. It will be seen that a small fragment of high explosive has struck the outer table of the left parietal bone near its anterior superior angle, a minute part of the missile becoming embedded at the point of impact. The inner table has been detached from an area twice as large as the contused area of the outer table.

In specimen No. 1.207 (*Figs.* 488*a*, 488*b*) there is represented a kind of wound very similar to the one just described, but showing injuries of a less degree. A fragment of high explosive—the soldier was struck in many other parts besides the head—has been embedded in the outer table of the right parietal bone just above the parietal eminence. The inner table is slightly depressed and fissured, but not detached as is the case in

Fig. 487*b*. The soldier was wounded on May 3, 1917, and died on May 16. There was an extradural hæmorrhage at the site of fracture, with œdema of the meninges.

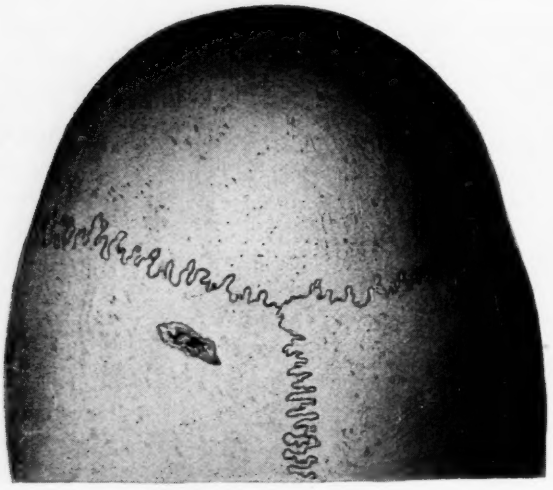


FIG. 487*a*.—No. 1.2011. Outer aspect of calvaria, showing a fragment of high explosive embedded in the outer table near the anterior superior angle of the left parietal bone.

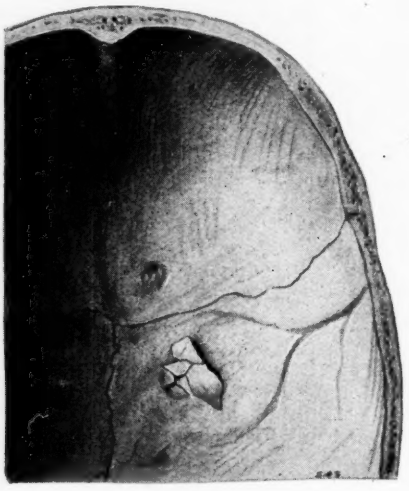


FIG. 487*b*.—No. 1.2011. The detachment of the inner table opposite the contused area shown in *Fig.* 487*a*, with rupture of meningeal vessels.

Specimen No. 1.2022 (*Figs.* 489*a*, 4 9*b*) is an example of detachment of the inner table, while the corresponding outer table has retained its normal level and contour. We

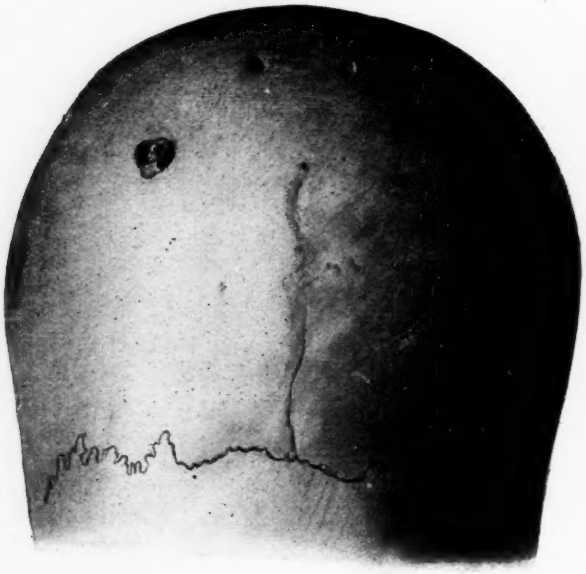


FIG. 488*a*.—No. 1.2071. Vertex aspect of cranium, showing a fragment of high explosive embedded in the outer table of the right parietal bone.

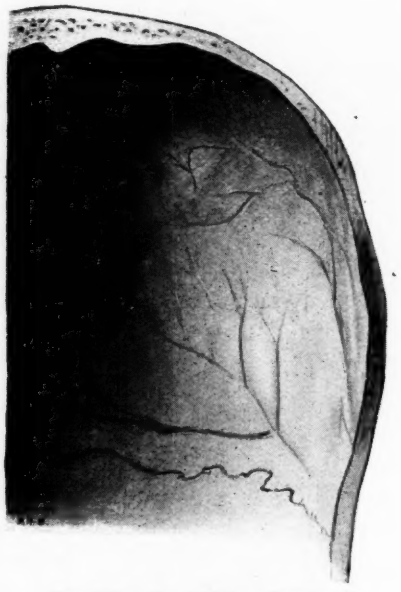


FIG. 488*b*.—No. 1.2071. Showing the inner table depressed and fissured opposite the area of impact shown in *Fig.* 488*a*.

were at first inclined to regard the injury shown in these figures as the result of a direct blow by a blunt missile ; but further experience has led us to suspect that we are

here dealing with a fracture caused by a missile moving tangentially to the contour of the parietal bone, and involving only the scalp and soft parts which cover the bone. On the outer surface of the skull, which is only 3 to 4 mm. in thickness, a fissure is seen to pass from the upper to the lower border of the right parietal bone (*Fig.* 489*a*), almost overlying the Rolandic fissure of the brain. Near the middle of this fissure there is a complex of minor fissures, which we regard as the area impacted by the missile in its tangential flight through the scalp. On looking at the interior of the parietal bone (*Fig.* 489*b*), we see that, opposite the complexity of fissures just mentioned, the inner table is extensively detached, the fragments being driven into the brain. An examination of the interior

FIG. 489*a*.—No. 1.2022. Outer aspect of skull, showing a fissure descending from the upper to the lower border of the right parietal bone, the result or a glancing wound.

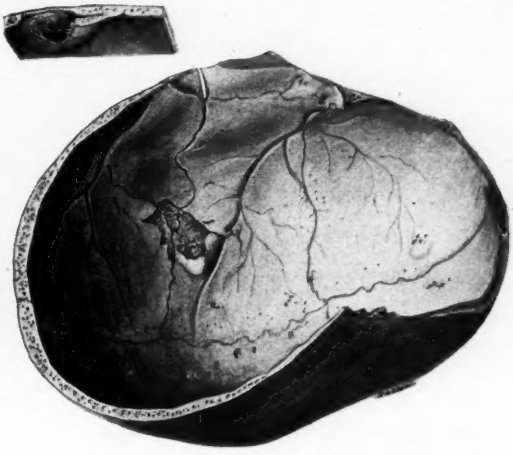


FIG. 489*b*.—No. 1.2022. The inner aspect of the specimen shown in *Fig.* 489*a*. An area of the inner table has been detached and driven into the brain.

reveals at the point of impact the arrangement of fissures characteristic of tangential or glancing blows. The usual four fissures are seen to radiate outwards, two diverging upwards and two downwards. The soldier was wounded on Aug. 15, 1917; he afterwards became unconscious, and died Aug. 25. At the post-mortem examination, the brain was septic, necrotic at the site of injury, and the meninges were inflamed.

(*To be continued.*)

A NEW METHOD OF TREATMENT FOR SUPPURATIVE ARTHRITIS OF THE KNEE-JOINT.

By Major J. EVERIDGE, R.A.M.C. T.

Current Methods of Treatment.—In spite of the dramatic progress in the surgical treatment of penetrating gunshot wounds of the knee, suppurative arthritis of this joint, when it occurs, has remained a condition often defeating our most painstaking endeavours.

Its treatment has been attempted by both surgical and chemical methods, the former having for their object joint drainage, the latter aiming at the destruction of bacteria by the application of one or another antiseptic. That joint drainage by purely operative measures is unsatisfactory is manifest from the multiplicity of methods which have been described from time to time. Anterior and posterior incisions, the turning up or turning down of a patellar flap, joint resection—all have had their adherents. The drainage tube inserted in the interior of the joint has long since been discarded. Similarly, the diversity of the antiseptics that have been used indicates the uncertainty of the action of each one of them. Either it is too irritating and still further lowers the vitality of the articular components already almost overcome by the septic processes, or, if it is non-irritating, its germicidal effect is so weak as to make its use of doubtful value. Further, to diffuse the antiseptic to all the numerous articular recesses where the germs lie hid is, in practice, impossible. The ideal antiseptic, in fact, has not yet been discovered.

After operating upon penetrating knee-joints, it has been almost the universal practice among British surgeons working in the war areas to adopt strict immobilization in the Thomas splint for at least ten days, and often much longer, after the temperature has settled.* Should suppuration occur, complete immobilization has been, more than ever, the unchallenged principle in treatment.

Disadvantages of Prolonged Immobilization.—I wish to draw particular attention to the fact that a limb long maintained at rest not only suffers muscular atrophy, but, worse, is also largely deprived of its blood-supply. The contracted state of the large arteries of the leg to be noticed when amputating a limb long immobilized is evidence of this. Further, elementary physiology teaches us that muscular action promotes the flow of blood in the veins. Finally, those experienced in war surgery are familiar with the frequency of tracking sepsis in legs where, for some reason or another, the main artery has required ligature. To illustrate this, I quote a series of 23 suppurating cases treated by me in 1917–18 by most careful immobilization with extension in suspended Thomas knee-splints; tracking took place in 17. In some, the pus tracked almost to the extremities of the limb. Four of these cases subsequently came to amputation (one in France and three in England). These facts make it appear reasonable to reconsider the advisability of complete rest in the management of such cases.

A Physiological Method of Treatment.—Realizing how great are the natural powers of resisting infection possessed by the joint, I have endeavoured to evolve a method of treatment wherein they are utilized to the utmost. I have ventured to call this system

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* An article[1] I published in the *British Medical Journal*, August 24, 1918, calls attention to the tendency to employ splints for unnecessarily long periods of time. It suggests a method where, by carrying out passive mobilization at first, a wide range of movement may be established with the least risk of 'stirring up' sepsis and breaking down healing tissues in and round the joint, while at the same time the formation of anchoring adhesions is prevented.

of dealing with an infected joint the 'physiological method,' for the natural processes of repair enter largely into its rationale.

This *alternative treatment* which I am recommending is consistent with physiological and pathological axioms, though in disagreement with the well-known doctrines of Hilton. It relies for its curative effect on active movements of the joints of the lower extremity, including the knee. It must be emphasized, however, that adequate openings into the infected joint must first have been established to allow the free escape of synovia and pus ; otherwise, movement will result in the dissemination of sepsis into culs-de-sac of the joint and extra-articular muscle planes.

Active movement of the joint will be begun soon after it has been operated upon, and is regulated under the supervision of the surgeon in charge or his assistant. The rationale of the procedure may advisedly be explained to the patient, who, realizing what is required, will usually lend his full co-operation. Still more will he do this when experience shows him that movements actually alleviate pain, coincident with the visible escape of pus from the joint. Active movements of not only the knee-joint but also the ankle are advisable, for the resulting contractions of the leg muscles will hasten the venous flow, thus diminishing capillary stasis, as evidenced by the absence of œdema of the foot.

To sum up, the advantages to be derived from treatment by early active mobilization appear to be five, its effects being :—

1. To hasten repair by the preservation of a good blood-supply to the tissues of the affected joint.
2. To aid drainage, as Willems[2] has emphasized.
3. To prevent extreme atrophy of the muscles, so that these will be better able to resume function when the articular inflammation is at an end.
4. To establish a process of auto-vaccination.
5. To realize the possibility of a subsequently mobile joint.

On the other hand, experience has shown that the treatment is not advisable in cases with gross injury to the articular bone or essential tendons or ligaments; or where suppuration in the joint has gone on for sixteen days or more.

THE SYNOVIAL FLUID.

The synovial fluid in the knee-joint is of such importance in the method of treatment I am advocating, that it is worth while to discuss its nature and modes of reaction to infection in detail.

Bacterial Invasion.

1. In 70 to 80 per cent of the cases of penetrating wounds of the knee-joint, this fluid at the original operation shows that 'soiling' has occurred. In most it is not possible to see and recognize organisms in it ; only on cultural examination can their presence be determined.
2. Where the 'toilet operation' has been successful, these organisms disappear. Subsequent effusion, should it occur, is found to be sterile.
3. Where the 'toilet operation' has failed, as rendered apparent by the persistence or recurrence of the clinical signs of inflammation more than four days after operation, bacteriological examination reveals organisms in profusion by both direct and cultural methods.

According to Sacquépée (quoted by Gosset[3]), in the first few days after joint penetration the number of visible germs in the articular effusion is appreciably less than in wounds of bone or muscle It is even the rule that in the first twenty-four hours direct examination reveals no organisms. Cultures, however, demonstrate their presence even when the examination is practised very soon after the wound. Where circumstances permit of further examinations, it is almost always found that there is a multiplication in germs up to about the sixth day, when symptoms of *infection* begin to arise.

The Cellular Elements.

1. At the original operation the identification of cells typical of inflammation

is generally prevented by the presence of red and white blood-cells resulting from a hæmorrhage into the joint.

2. In the absence of such a hæmorrhage, a preponderance of leucocytes is not pathognomonic of severe septic infection of the joint.

3. A differential leucocyte count affords evidence in determination of infection. An 80 per cent polynuclear count marks roughly the dividing line between good and bad prognosis (Lazarus Barlow[4]).

4. The presence of extracellular organisms and the absence of phagocytosis, when suppuration has lasted for ten days, point to a severe infection and limitation of powers of resistance. Too much reliance, however, should not be put upon this observation.

The following changes in the nature of the fluid escaping from a joint, during the progress of suppurative arthritis, to a certain extent reflect the clinical evolution of the intra-articular inflammation. Three stages may be recognized :—

A. Developing.

1. (*a*) Synovial fluid discoloured by altered blood ; (*b*) Albuminous fluid like coagulating white of egg.
2. Sero-purulent fluid.

B. Established Suppuration.

3. Pus. (*a*) Thick and creamy in staphylococcal infection ; (*b*) Thinner and less viscid in streptococcal infection.

C. Subsidence.

4. Pus with semi-solid curds.
5. Curds floating in a clearer fluid.
6. Synovia, clear and limpid.

The appearance of the last two types of escaping fluid is valuable as evidence of resolution of intra-articular inflammation. Histologically, the last reveals few polymorphonuclear cells and, as a rule, no extracellular organisms, the few bacteria present being intracellular.

(At this stage, should large open wounds be present with healthy vascular granulations, and if no pus is apparent, either as a secretion of the granulating surface or escaping from a sinus leading to necrosed bone, it is safe to carry out partial or complete secondary suture. This step is advisable, for dense cicatrices, which are subsequently of considerable inconvenience, may best be avoided by early suture.)

Synovial Fluid as a Natural Germicide.—A joint subjected to an irritant, whether mechanical, chemical, or bacterial, reacts by an inflammation of the synovial membrane and the outpouring of an excess of synovial fluid into the articular cavity. In which articular components do the germicidal properties chiefly reside ? The only three tissues which can supply this protection are :

(1) The synovial membrane ; (2) The synovial fluid ; (3) The cartilage (either the menisci or that clothing the bone).

On account of the avascularity of the third, only limited powers of resistance can be ascribed to this structure. The synovial membrane, on account of its good blood-supply, should be competent to protect itself.

The most valuable germicidal agent of the joint must be the synovial fluid. This, after all, is but slightly altered from blood plasma, and no doubt is endowed with all the protective qualities which the blood itself possesses. We should expect to find that the protective value of it would vary directly as the supply of freshly oxygenated blood. The supply is largely governed by muscular action, involved in active movements. A flushing of the interior of the joint with fresh synovia, especially the more vulnerable components, such as the cartilages, I believe to be a factor of importance in the natural recovery from joint infection.

Sacquépée's observations, mentioned already, coincide with the opinion held by Veillon,[5] who regards synovia as being powerfully germicidal provided that it is freshly secreted ; if allowed to stagnate, it loses this property, and becomes instead a good culture-medium for bacteria.

It appears probable that the operation of paracentesis followed by the injection of an antiseptic fluid, referred to by Lockwood[6] and others, owes its success in arresting sepsis in certain early cases of suppurating knee-joints to the withdrawal of synovial fluid rather than to the antiseptic instilled. It is not easy to see how a solution such as 2 per cent formalin-glycerin could kill all the germs in an infected joint ; many of these lie concealed in synovial recesses and in blood-clot far beyond the reach of any antiseptic injection.

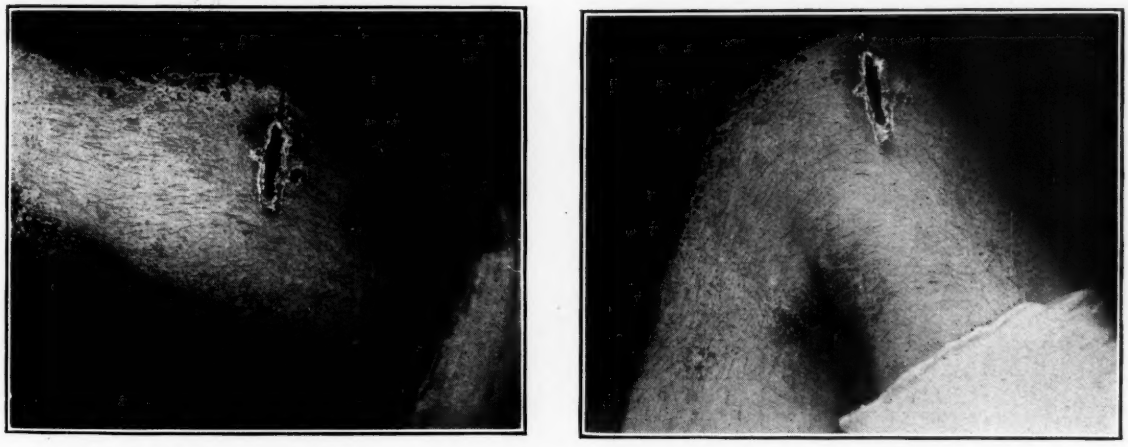
Describing penetrating gunshot wounds of the knee-joint, various observers give the percentage of instances in which 'soiling' of the synovial fluid with organisms has occurred as between 70 and 80. Where a fragment of high-explosive shell is lodged in the joint, the introduction of germs is bound to have occurred ; yet the vast majority of such cases run an aseptic course after the removal of the foreign body and the performance of a 'joint toilet' on the lines so ably laid down by Colonel Gray.[7] The operation no doubt removes a considerable number of the organisms and infected material ; a large residue, however, must remain, and is dealt with efficiently by the synovial fluid.

In the 20 to 30 per cent of failures, where the mass-action of infection has been too great, and clinical 'sepsis' as distinguished from 'soiling' has occurred, the aim of subsequent treatment will be : (1) To ensure a free outlet for synovia ; (2) To preserve the best possible blood-supply to the joint structures; and, as a corollary, (3) Thereby to provide a supply of the healthiest synovial fluid, that is, synovia best equipped with vigorous phagocytes and antibodies.

PRACTICAL DETAILS OF THE PHYSIOLOGICAL METHOD.

The Formation of Adequate Joint Stomata by Operation.—The stereotyped vertical parapatellar incisions commonly used for drainage of the knee-joint have the following drawbacks :—

1. Wide gaping of the skin owing to the run of the natural lines of cleavage in this situation. The result is wounds taking long to heal, and ultimately leaving troublesome cicatrices.



FIGS. 490, 491.—The condition of the transverse arthrotomy incisions, with skin-synovial suture, one month after receipt of the wound, which produced a staphylococcal arthritis.

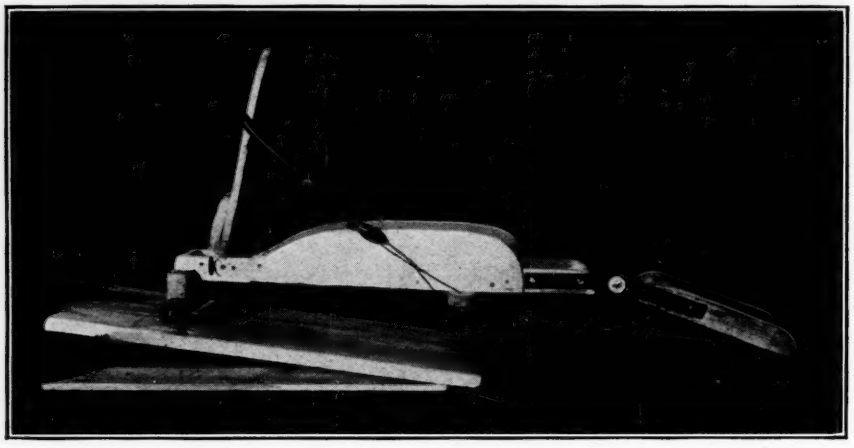
2. Joint openings which tend to close early, since the split muscle and tendinous fibres forming the capsule fall together spontaneously.

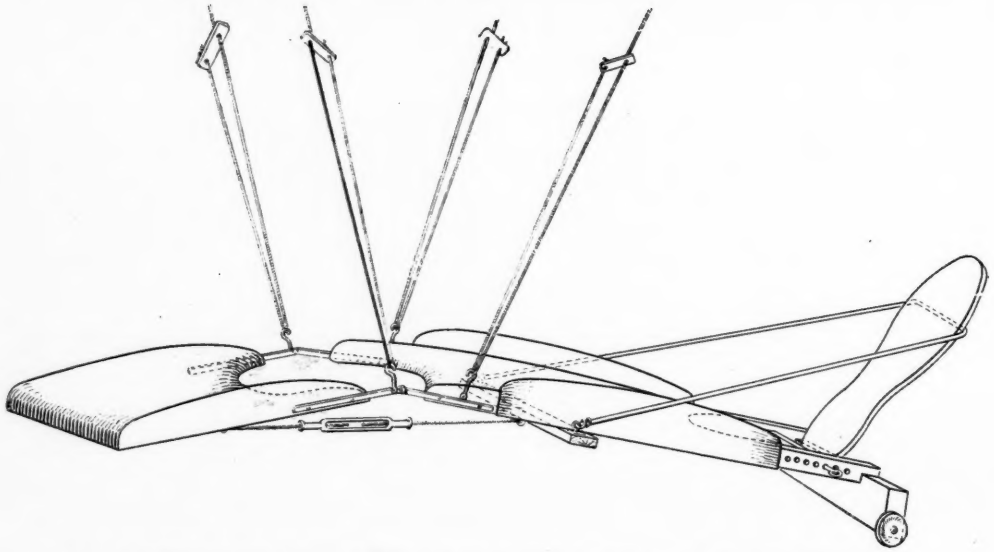
3. Interference with the blood-supply of the patella, since the main vessels, which pass transversely inwards, are divided by these incisions.

4. Troublesome hæmorrhage either at the time of the operation or some hours later. The bleeding vessels shrink away into fibrous tissue when cut, and are difficult to secure.

5. Should amputation subsequently become necessary, the anterior flap is interfered with.

Owing to these drawbacks, I have for some time past been in the habit of using transverse incisions (*Figs.* 490, 491). These remain open satisfactorily and, where active mobilization is employed, appear to drain the joint just as efficiently as the vertical incisions. They are made from the outer and inner borders of the patella, commencing at





FIGS. 492, 493.—'Active movement' splint. It can be made rigid by fixation of the adjuster below the knee. Note the adjustable foot-piece, supported by elastic slings.

the junction of the upper and middle thirds of the bone, and continuing for a distance backwards of about an inch and a half. These incisions are far removed from the lateral ligaments, which lie below and behind them. The outer incision partially divides the iliotibial band.

All structures down to and including the synovial membrane are divided in the line of the skin incisions. As a final step, the cut edges of the synovial membrane are stitched to the cut edges of the skin by a series of suspension sutures. A single layer of rubber tissue is inserted between the lips, and left *in situ* for twenty-four hours, to prevent the closure of these openings by adhering blood-clot.

If the muscles of the thigh are unusually well-developed and do not retract sufficiently to leave adequate joint openings, an elliptical segment is excised on either side.

Active Mobilization.—To persuade a patient suffering from an early suppurative arthritis of the knee to carry out active movement is, in practice, by no means easy. He is ill, weak from fever and possibly from loss of blood ; and, moreover, his joint is excessively painful. Without some help he will be able to do little or nothing. He cannot raise his leg off the bed, far less bend and straighten the knee. For these reasons I have constructed an apparatus, the description of which follows, by means of which gravity is practically eliminated.

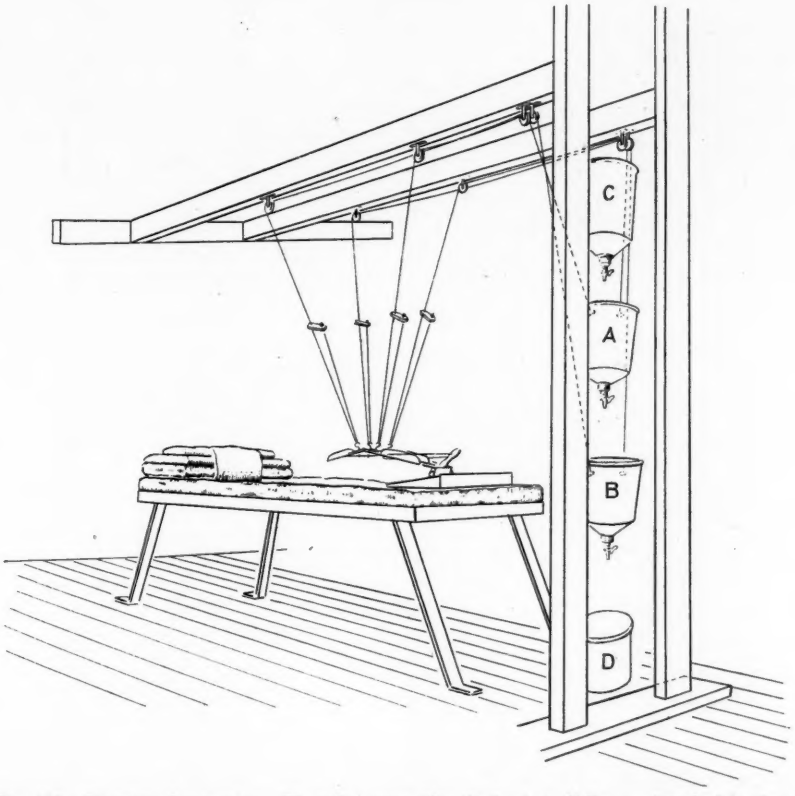
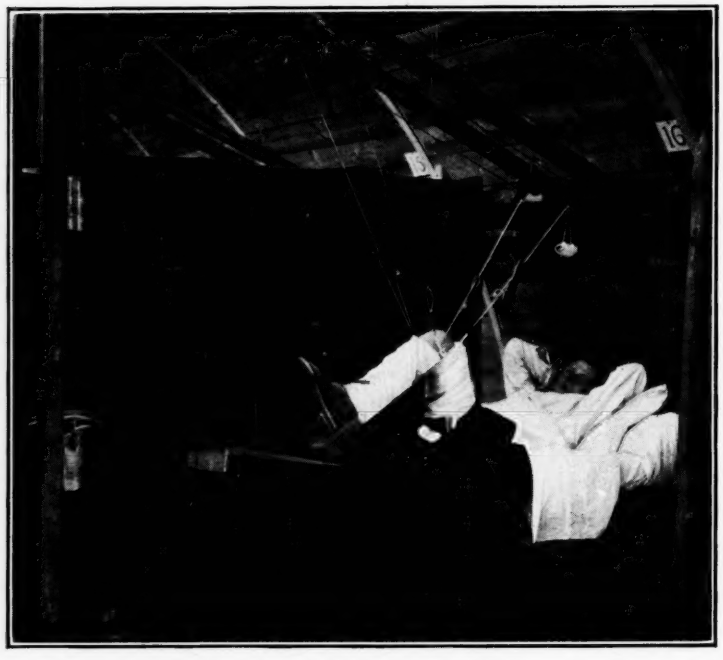


FIG. 494.—Diagram of apparatus. The splint supporting the leg is partially counterpoised by the conical sand reservoirs A and B. The shape of the reservoirs enables an easy adjustment of the weight of sand, for, by means of a tube of outlet controlled by a tap in each, sand can be allowed to flow from one to the other. C is not a counterweight ; it is a fixture, and acts as a cistern for the supply of any additional sand necessary to A, or through A to B. D is for waste sand (excess from B).

APPARATUS.—This comprises : (1) A suitable splint ; (2) An overhead counterpoise system.

1. *The Splint* (*Figs.* 492, 493).—This is an elaborated back splint with foot-piece, and possesses the following features :—(*a*) It is guttered to fit the shape of the leg. (*b*) It is interrupted, where it lies behind the knee, to give access for inspection and dressings. (*c*) The metal bars bridging the interval are jointed. (*d*) An adjuster is fitted like that supplied with the standard McIntyre splint. This is made easily

detachable; when removed, there is freedom for knee movements. (*e*) A footpiece is supplied, adjustable in position according to the length of the leg. It is pivoted on



FIGS. 495, 496.—Demonstrating the apparatus in use.

the adjusting pin, and held up by two elastic slings. Thus the foot is maintained in dorsiflexion when at rest. (*f*) Running wheels are attached below the foot end of

the splint. These prevent friction, and allow a free excursion up and down a platform on which the splint rests.

2. *The Counterpoise System* (*Figs.* 494, 495, 496).—That shown in the accompanying figures may appear somewhat complicated. It is the standard pattern I have established in France for the treatment of suppurative arthritis and other conditions of the knee-joint. It has many practical advantages, but an enumeration of these would somewhat complicate the present consideration.

All that is really essential is four pulleys attached somehow above the leg. These transmit four cords, two of which are attached just above, and two just below, the hinges of the splint. At their other ends are fixed counterweights (sandbags, etc.). These are not quite heavy enough to suspend the leg in the air. They merely serve to overcome most of the force of gravity. With this arrangement the patient's limited energy may be economically spent on movements at the knee, and not wasted on the purposeless act of lifting the leg from the bed.

Active movements are at first carried out under the observation of the surgeon or his trained assistants. The splint is fixed by re-applying the screw adjuster at all times when jars, twists, or strains might occur, such as during sleep, nursing procedures, etc. Experience shows that normal movements of flexion and extension are singularly painless provided there is a free outlet for fluid from the joint, preventing any rise in intra-articular tension.

Patients soon become interested in the routine, and enjoy considerable relief of pain when the daily movements are carried out. In fact, they often ask that the splint may be released, in order to ease their discomfort by movement. Emphasis is again laid on the importance of movements of the foot. Active contractions of the muscles of the leg stimulate the flow of blood and prevent the occurrence of œdema from venous stasis. Possibly, also, contractions of the gastrocnemii help to massage up pus from the posterior compartments of the knee-joint.

The physiological method, in order to be of service, must be instituted *early*. It is useless to commence it when all the joint structures are becoming disintegrated by septic processes, and especially when the cartilages are becoming eroded.

For this reason I believe it unwise to resort to the operation of arthrotomy, lavage, and closure, where signs of sepsis occur as late as a week after the date of the original wound or primary operation. It is wiser to avoid the waste of time incurred by this operation, which, more often than not, fails to arrest sepsis at so late a stage. Each day's delay renders the mobilization method less likely to succeed, and lessens the chance of obtaining a movable joint at the finish.

PARTICULARS OF CASES.

To illustrate the type of case which lends itself to this method of treatment, the following may be quoted as good examples : –

Case 14.—L.-Cpl. T. Received a shell wound of right thigh and knee, Oct. 15, 1918. At the casualty clearing station a piece of high-explosive shell was removed from the extensor muscles just above the outer angle of the patella. The wound was excised and sutured ; the knee-joint at this operation did not appear to be involved. The patient was admitted under my care on Oct. 17. On Oct. 21 the knee was painful and slightly swollen, the temperature 100°. On paracentesis the following day, turbid coagulating fluid was withdrawn from the joint. Histologically examined, this was seen to be rich in pus cells and staphylococci. In consequence, the wound was reopened, internal transverse arthrotomy (by the method described above) was done, and the joint washed out with saline. Immediate active mobilization was instituted. Movements were good from the first, and the temperature and pulse settled in the course of a few days. On Nov. 4 active flexion could be carried out through a range of 100°, and by this time the fluid escaping from the joint had become clear and limpid, resembling typical normal synovia. Two days later fluid had ceased to escape. By Nov. 18 the wounds were healing well, there was full range of active movement, and the patient was getting up and able to walk a few steps. On Nov. 20 he was sent to England, with the right knee-joint normal to all outward appearances,

except for incompletely healed wounds. The accompanying photographs (*Figs.* 497, 498) show the range of movement thirty days after the receipt of the original injury. Two and a half months from the date of injury, the report from England stated that the wounds were healed, there was full range of movement, no swelling of the joint, and the patient could walk two miles.

FIG. 497.—*Case* 14, one month after shell wound of the knee which produced a septic arthritis.

FIG. 498.—The same case, showing that at this time a complete range of movement was possible.

Case 17.—Gnr. D. Received a shell wound of right knee on Oct. 23, 1918. The fragment of shell was removed the following day at a casualty clearing station; the joint was washed out with Dakin's fluid and closed. The patient was admitted under my care on Oct. 25, when the whole joint was very much swollen, the skin was œdematous, and there was great tension on the lower stitches of a long antero-internal arthrotomy wound. Some of the stitches were immediately removed. The next day paracentesis was done, and suppurating blood clot removed from the joint. On examination, this fluid contained pus cells, *B. Welchii*, and staphylococci in profusion. Accordingly the same day an external transverse arthrotomy with skin-synovial suture was done. At the same time the lower part of the original wound, where it lay over the joint, was opened,

and the skin stitched to the synovial membrane. The joint was washed out with saline, and, of course, left open. In the course of eleven days the temperature had settled and active movement through 82° was easy. By Nov. 21 there was full range of active movement, and the wounds were granulating well, fluid having ceased to escape from them. On Nov. 25 the patient was getting up and could bear weight on the limb. (See *Figs.* 499—502). By Dec. 15 he was able to walk long distances without a stick, and there was hardly any perceptible lameness.

In the more virulent types of inflammation, and especially when it is associated with gross bone injury, movements towards the end of the third week may become restricted and painful. If this is not due to a collection of pus in the popliteal space, it is regarded as coinciding with erosion of the articular cartilages, and is the signal for the application of a rigid Thomas splint with extension, hope of a mobile knee being no longer entertained.

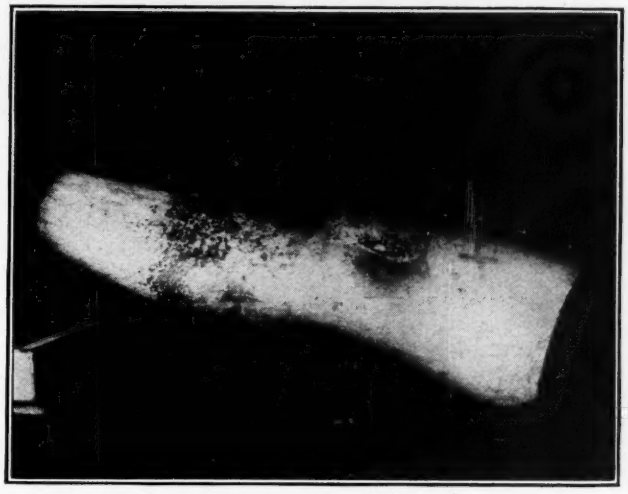


FIG. 499.—*Case* 17, five weeks after removal of missile which produced a suppurative arthritis (staphylococcus and *B. Welchii*). The lower part of the original operation wound was converted into a joint stoma.

Such an occurrence is not to be regarded as complete failure, for experience shows that the measures adopted early have served the following purposes: (1) Prevention of tracking; (2) Hastening of resolution of the septic processes within the joint by stimulation of the synovial circulation; (3) Limitation of the intensity of the inflammation and of toxic absorption.

Not the least striking feature when this treatment is carried out is the satisfactory general condition these patients preserve. Their appetites remain good; they sleep well; take interest in their surroundings; and, in fact, present an entirely different picture from that which we were accustomed to see when treatment by immobilization was carried out.

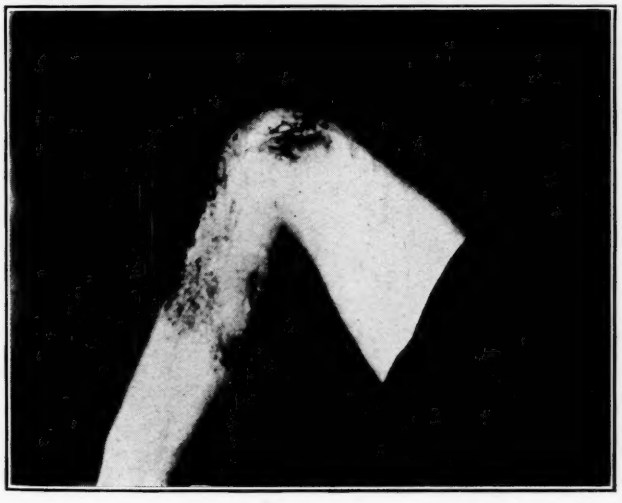


FIG. 500.—The same case, showing range of movement.

Though the tendency to track is overcome, a localized abscess frequently occurs in the popliteal space.* It is not quite clear whether this comes about by an extension through the back of the joint by way of the bursæ, or by a track superficial to the condyles. These abscesses occurred in 10 out of 23 cases treated by the physiological method.

* The occurrence of pain, swelling, and œdema in the popliteal space is an indication for an immediate exploratory incision.

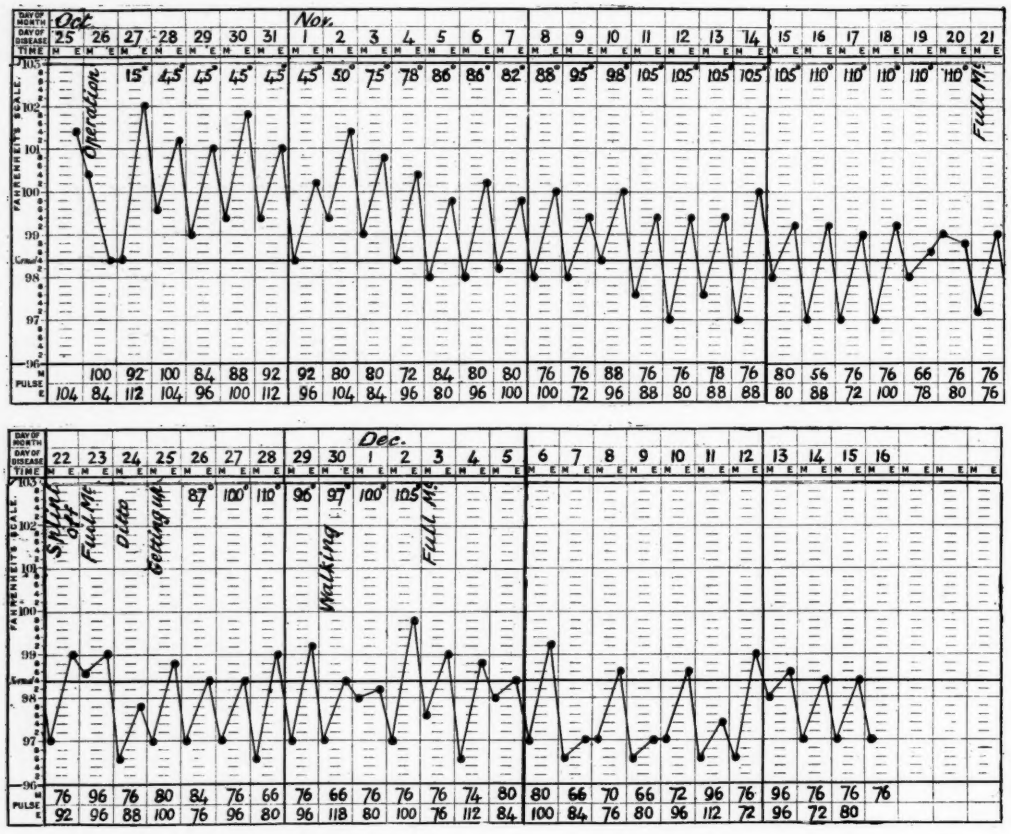


FIG. 501.—Temperature chart of *Case* 17. The increment in range of active movement is indicated by the number stated in degrees. Note the steady pulse-rate and gradual subsidence of temperature.

FIG. 502.—Skiagram of *Case* 17 at the sixth week. To demonstrate that absorptive changes in the bone are very limited, extending only a short distance into the depth of the cancellous tissue. There is no subperiosteal deposit of new bone.

That a joint treated by the physiological method may sterilize itself is evident from the following case :—

Case 8.—Bdr. M. Developed a streptococcal arthritis after a shell wound, which caused a very septic compound fracture of the fibula, and injury to the popliteal artery necessitating its ligature in addition to the joint lesion.

The joint was treated by the physiological method. On the twenty-ninth day it became necessary to amputate, owing to extensive suppuration in the lower part of the leg, the consequence of ligature of its main artery. Examination of the amputated limb showed that the interior of the knee-joint was in a satisfactory state. There was no pus, merely a little clear fluid, upon which the pathological report was as follows : in 50 fields there were 114 polymorphs, 34 lymphocytes, and 4 cocci.

Such a degree of recovery in a very acute streptococcal joint after twenty-eight days' treatment offers convincing proof of its efficacy. The joint fluid, in fact, revealed a condition of cleanliness which almost conformed to Carrel's standard of 'clinical sterility.'[8]

The *Table* on p. 578 shows that about 50 per cent obtained a mobile knee. There were no deaths in the series, and the one amputation (*Case* 8) was necessary on account of intractable suppuration in the leg resultant upon ligature of the popliteal artery ; the knee-joint, subsequent examination showed, had settled down completely. In each of these cases the knee-joint was definitely infected and in one of the various stages of suppuration ; not one was merely a 'soiled' joint. It will be observed that in no instance where movements were commenced after the seventh day did a mobile joint result. Mobilization, however, in these cases undoubtedly served a useful purpose, and the end-results, though ankylosis occurred, were very good.

A practical difficulty lies in deciding upon the length of the period of probation, for in many cases of suppurative arthritis acute symptoms are not manifest until as late as the tenth day, and the fact that effusion into the joint is occurring may escape notice by the leakage of synovial fluid into the depth of an open wound near the joint. Many coincident conditions may be factors in producing pyrexia, increased pulse-rate, and other symptoms of toxic absorption. In some cases—necessarily not included in the foregoing list—the local signs, the symptoms, and the withdrawal of a synovial fluid rich in polynuclear leucocytes have prompted me to adopt the physiological method of treatment without delay, knowing that evidence of the existence of bacteria might require forty-eight hours to be reliable, the time necessary for incubation of organisms dilatory in growth on artificial culture media. In no case where the pathologist's report was subsequently negative for bacteria did contamination of either the stomata or the interior of the opened joint occur, and progress to free mobility was unhindered.

SUMMARY AND CONCLUSIONS.

1. All surgical methods of draining the knee-joint in suppurative arthritis have certain drawbacks.

2. The physiological method of treatment described above endeavours to provide : (*a*) A circulation of synovial fluid with maximum powers of resistance, in virtue of a free blood-supply to the affected joint ; (*b*) Free drainage for pus.

3. The practical requirements of the treatment are : (*a*) Free outlets for fluid from the joint ; (*b*) Active movements.

4. In about 50 per cent of the cases treated a useful mobile joint has been obtained.

5. In the absence of extensive bone injury—which necessarily negatives this treatment—provided the physiological method is established early, resolution is hastened and tracking is rare. Collections of pus in the popliteal space occur frequently.

6. The method is impracticable if its adoption be delayed until the establishment of the fulminating stage of suppurative arthritis.

TABLE OF CASES TREATED BY THE PHYSIOLOGICAL METHOD.

CASE NO.	ORGANISMS	BONE INJURY	EXTRA-ARTICULAR SUPPURATION	DAY WHEN ACTIVE MOVEMENTS BEGAN	RESULT
1	Staphylococcus .. .. Streptococcus (long chain)	Femur	*Thigh, aborted	11th day	Ankylosis
2	Staphylococcus .. .. Streptococcus (long chain)	Femur	*Thigh, aborted Popliteal	15th ,,	Ankylosis
3	Staphylococcus .. .. Streptococcus	Tibia and patella ..	*Thigh, aborted Popliteal	10th ,,	Ankylosis
4	Diphtheroids Streptococcus (short chain)	Femur	—	7th ,,	90° mobility
5	Staphylococcus .. .. Streptococcus	None	Popliteal ..	5th ,,	105° ,,
6	Staphylococcus .. .. Streptococcus	Femur	—	4th ,,	90° ,,
7	Staphylococcus .. .. Coliform bacillus	Tibia, femur, and patella	—	6th ,,	60° ,,
8	Staphylococcus .. .. Streptococcus (long chain)	Fibula	Popliteal ..	4th ,,	Amputation
9	Staphylococcus	Patella	Popliteal ..	5th ,,	Ankylosis
10	Staphylococcus .. .. Streptococcus	Femur	Popliteal ..	11th ,,	Ankylosis
11	Staphylococcus .. .. Coliform bacillus	Femur	2 in. up from external arthrotomy wound	10th ,,	Ankylosis
12	Staphylococcus	Tibia	Popliteal ..	6th ,,	Ankylosis
13	Staphylococcus .. .. Streptococcus	Patella	Suppurating hæmatoma of thigh	9th ,,	Ankylosis
14	Staphylococcus	None	—	7th ,,	Full mobility
15	Streptococcus .. .. Coliform bacillus	Femur	—	4th ,,	45° mobility
16	Staphylococcus .. .. Coliform bacillus	Patella	Popliteal ..	5th ,,	Ankylosis
17	Staphylococcus .. .. *B. Welchii*	Femur	—	5th ,,	Full mobility
18	*B. Welchii*	Patella	—	7th ,,	Full mobility
19	*B. Welchii*	Femur	—	3rd ,,	Full mobility
20	Streptococcus (long chain)	Tibia	Popliteal ..	4th ,,	Ankylosis
21	Staphylococcus	Femur	—	7th ,,	50° mobility
22	Staphylococcus	None	—	6th ,,	Full mobilitty
23	Streptococcus (long chain)	Femur	—	13th ,,	Ankylosis

* By this is meant that at the time of my original operation pus had extended through the subcrural bursal reflection. No further tracking ensued.

REFERENCES.

1 EVERIDGE, *Brit. Med. Jour.*, 1918, Aug. 28.
2 WILLEMS, *Comptes Rendus de la Conférence Interalliée pour l'Etude des Plaies de Guerre*, 1917, Nov.
3 GOSSET, *Ibid.*, March.
4 LAZARUS BARLOW, *Brit. Med. Jour.*, 1916, Dec. 30.
5 VEILLON, *Comptes Rendus de la Conférence Interalliée pour l'Etude des Plaies de Guerre*, 1917, March.
6 LOCKWOOD, *Brit. Med. Jour.*, 1916, Jan. 29.
7 GRAY, *Ibid.*, 1915, July 10.
8 CARREL, *Le Traitement des Plaies Infectées.*

WAR CONTRACTURES—LOCALIZED TETANUS, REFLEX DISORDER, OR HYSTERIA.

By Lieutenant-Colonel ARTHUR F. HURST, R.A.M.C.,
Seale Hayne Military Hospital.

From an early date in the War there was much controversy as to the nature of the frequent cases in which contractures occur as a result of injuries to the soft parts of the limbs, with or without the bones and joints being involved. The contractures are generally discovered when the dressings and splints are removed, but they may be noticed directly after the infliction of the wound, or only develop gradually several weeks later.

The War Office Committee for the Study of Tetanus circulated questions as to the frequency of muscular contractures after injuries among the "principal surgeons in England, especially those whose practices are among the large industrial classes, where injuries in civil life are common." Answers were received from about eighty surgeons, only one of whom had ever seen such a sequel of a wound. The result of the inquiry is remarkable, for I have seen frequent cases of contracture following injury in civil life; and I have no doubt that if the questions had been sent to neurologists and orthopædic surgeons, very different answers would have been obtained. In the following case, for example, the man was rapidly cured by psychotherapy of a contracture of the hand, which had developed after amputation of a finger five years before he joined the Army.

Fig. 503.—Hysterical contracture of six years' duration following amputation of finger.

Hysterical contracture following amputation of a finger, of six years' duration, cured by psychotherapy in an hour.

Pte. W., age 26, had the third finger of his left hand amputated in April, 1912, for blood-poisoning. Following the operation, all the fingers of the hand became rigidly flexed (*Fig.* 503), but no treatment was given. He was admitted into the Army in April, 1917, in spite of his disability. He was employed on light work for the following eleven months, and was then admitted under us. He was treated by manipulation and persuasion, and in an hour there was complete relaxation of the fingers (*Fig.* 504). Next day, under further treatment by persuasion and re-education, movement in all the joints was obtained. At the end of three weeks his hand was quite strong, and he was able to use it for all ordinary purposes. (Major J. L. M. Symns.)

Fig. 504.—Same hand as *Fig.* 503 after an hour's treatment.

Localized Tetanus Theory.—Having received these answers, the Tetanus Committee came to the conclusion that the condition must be a new one, which had arisen as a result of some special circumstances arising in the present war, and they ascribed it to localized tetanus, which had never been recognized in man before, but which undoubtedly occurs now that the routine administration of prophylactic injections of antitetanic serum has caused generalized tetanus to become comparatively rare. Most of the speakers at the conjoint meeting of the Sections of Surgery and Neurology of the Royal Society of Medicine with the Tetanus Committee, held as recently as Feb. 14, 1918, to discuss "Muscle Contractures following Injury," appear to have believed that localized tetanus is the explanation in the majority of cases.

Until the present war the only form of localized tetanus which had been recognized was the so-called cephalic or head tetanus. A few cases had been recorded in which the spasms began in the injured limb and remained most severe in it after generalization occurred; but the first case of tetanus, in which the symptoms were strictly localized to one limb throughout the illness, was described in May, 1915, by Courtellement. Numerous observations on the subject have been published in France and England since that date, but even now many cases of localized tetanus probably escape recognition through want of familiarity with the condition.

Most cases of localized tetanus which occurred before the middle of 1915 must have been diagnosed as traumatic hysterical contracture, and five out of the nine cases I have seen were at first regarded as hysterical. On the other hand, the contractures in at least two cases which have been published as examples of local tetanus must really have been hysterical in origin, as they developed immediately after the wound was received, although it is impossible for tetanus to develop until the bacilli introduced in the wound have had time to produce the toxin, which has then to travel to the central nervous system before it can give rise to symptoms.

In the early stages the diagnosis between localized tetanus and hysterical spasm may be extremely difficult. If the contractures persist without abating for more than three or four weeks, and do not disappear completely at the end of six or eight weeks, they are probably hysterical, even if they were at first due to tetanus. Spasms which begin immediately after the wound is inflicted cannot be due to tetanus; they are generally reflex and protective in nature, but are often maintained after the first few hours or days by autosuggestion. A later onset is compatible with both tetanus and hysteria, and in both the extent of the contracture is often out of all proportion with the size of the wound. If the contracture persists in sleep, hysteria can be excluded. A general anæsthetic causes hysterical contractures to disappear more rapidly than tetanic contractures, which persist to some extent even under deep anæsthesia, although even the former may still be present after consciousness is lost. If the muscles are of a wooden and unvarying hardness, tetanus is almost certainly present. An increase in the size of the muscle, possibly due to obstruction of its lymphatics, without tenderness or subcutaneous œdema, is conclusive evidence in favour of local tetanus. The continued tonic contraction in tetanus is generally accompanied by spasmodic and more or less painful contractions, which are often brought on by external stimuli. When there is any doubt as to the diagnosis during the first week, the condition should be assumed to be local tetanus, as it is never possible to say whether generalization may not develop later. Early injections of antitetanic serum should prevent this, and they will do no harm if the spasms are not really due to tetanus. After contractures have persisted for a month, they should be regarded as wholly or in part hysterical in origin, and psychotherapy should be employed without further delay.

Reflex Theory.—Babinski and Froment believe that many of the contractures which have hitherto been regarded as hysterical, or due to some obscure condition such as an ascending neuritis, as believed by Tinel, are really reflex in origin. They have summarized their views in the second section of their book published in 1917 on *Hystérie-Pithiatisme et Troubles Nerveux d'Ordre Réflexe en Neurologie de Guerre*. This theory at first seems to offer a satisfactory explanation of many cases, the nature of which had hitherto remained obscure; but a critical investigation of the subject has convinced us that such reflex conditions never occur.

Babinski and Froment admit that reflex symptoms resemble hysterical symptoms in being quite out of proportion with the often trivial injury which gave rise to them, but state that they differ in being entirely unaffected by psychotherapy and in certain clinical features. The former distinction I have already criticized, as in our experience rapid recovery always follows persuasion and re-education. The clinical features, which were believed by Babinski and Froment to exclude the possibility of hysteria, are discussed in a later section, where they are shown to be secondary to the impaired venous and lymphatic circulation, caused by the disuse resulting from hysterical paralysis and contracture.

There is no doubt that reflex contraction of the neighbouring muscles is not uncommon

immediately after a wound is inflicted, the reflex being protective in nature, just as is the reflex contraction of the abdominal muscles in acute appendicitis or after perforation of a gastric ulcer. When, however, the symptom persists after the wound has healed, it is no longer due to any reflex action, but is the result of suggestion ; the contracture is thus primarily reflex and subsequently hysterical.

Hysteria.—Our own observations have led us to the conclusion that hysteria is invariably the cause in chronic cases, and that even when localized tetanus or a reflex spasm is present at the onset, any symptoms which persist are due to perpetuation by suggestion ; they are thus eventually hysterical.

The matter is by no means of merely academic interest. If the contracture is due to localized tetanus, the proper treatment would be by injections of antitetanic serum. If the reflex theory of Babinski and Froment is correct, the patients can only be very slowly cured after months of treatment by physical methods. If, however, the contractures are hysterical in origin, they should be curable at a single sitting by psychotherapy.

When hysterical contractures are erroneously diagnosed as being due to localized tetanus or reflex action, the correct treatment will not be undertaken. Thus Wilfred

FIG. 505.—Hysterical contracture of hand of fifteen months' duration, cured by suggestion.

Harris, who apparently regards the condition as frequently due to tetanus, states that "these cases are most resistant and difficult to treat." He has tried to straighten the fingers and put them into splints under an anæsthetic, but without success. In the same way the popularization of the idea of reflex symptoms, by the publication of Babinski and Froment's book, and its translation into English, is likely to lead to hysterical conditions being diagnosed as reflex, with the result that they will not receive the benefit of psychotherapy, which would otherwise have cured them. It is a curious fact that Babinski, who more than any other neurologist has demonstrated the important part taken by suggestion in the origin of hysterical symptoms, and has shown how they can be cured by suggestion, should himself have become a victim of suggestion ; for, having made up his mind that these contractures are reflex, and therefore not amenable to psychotherapy, he has failed to cure them by psychotherapy, and has described this failure as one of the most characteristic features of the condition.

The following case, which was the first one I saw after reading Babinski and Froment's book, illustrates how an implicit belief in their teaching would have led us to neglect psychotherapy, without which the patient could not have been cured.

Hysterical contracture and paralysis of fifteen months' duration, at first supposed to be reflex,' cured by suggestion.

Pte. W., age 21, received a slight wound in the hand in May, 1916. When the dressings were removed, his hand was found to be fixed with the fingers semiflexed and the thumb adducted. Movements of the elbow and wrist were normal, but he could make no movements with the fingers or thumb. The wound soon healed, but the condition of the hand persisted in spite of massage and electricity. It had been supposed that the contracture was due to adhesions involving the tendons and palmar fascia. I first saw him in August, 1917, fifteen months after the wound was received. No improvement had occurred, the fingers and thumb being still flexed (*Fig.* 505); but it was found that the contracture could be slowly overcome by force. When a voluntary effort was made to move the fingers or thumb, the affected muscles were seen to contract, but no movements resulted, as the muscles opposing the desired movement also contracted instead of relaxing. There was no atrophy, and the electrical reactions were normal. The hand was swollen; it was red when the room was warm, and blue when it was cold, a considerable difference in temperature between the two hands being present always; excessive sweating also occurred on the palm of the affected hand.

The condition would have at once been diagnosed as hysterical, had it not been that a recent study of Babinski and Froment's work on reflex paralysis and contracture led to the suggestion that this was an example of such a reflex condition, as the position of the hand was identical with that shown in one of the figures in their book, and œdema, vasomotor changes, and excessive sweating—which, according to them, never occur in hysteria but are common in reflex disorders—were present.

As I wished to see how much relaxation occurred under anæsthesia, ether was given. The contracture relaxed more slowly than would have been expected in hysteria, this seeming at first to confirm the diagnosis of a reflex condition; but as I was still doubtful as to whether the condition might not be hysterical, I tried the effect of vigorous suggestion with the aid of electricity as the patient was coming round. With this treatment the muscles relaxed and all movements became possible. During the next few days treatment by re-education was continued, with the result that ten days later the patient was able to use his hand for all ordinary purposes. Simultaneously with the disappearance of the contracture and paralysis, the œdema, sweating, and vasomotor disturbances completely disappeared.

PATHOGENESIS.

The posture in hysterical contractures is identical with that which happened to exist at the time the contractures developed, and is in many cases that which was assumed immediately after the injury. Thus, if one or more peripheral nerves were damaged, the position corresponds with what would result from paralysis, or occasionally from irritation, of these nerves. In such cases, when the nerve recovers from the effect of the injury, which may be within a few hours if the latter is nothing more than slight concussion, or may be weeks or months if it is more serious, the abnormal posture and the inability to move are maintained as a result of suggestion.

In other cases the injury may lead to reflex spasm of the neighbouring muscles and inhibition of movement of the whole limb, which is protective in nature, but which rapidly disappears as the condition of the wound improves. Apart from this reflex action, the patient more or less subconsciously assumes the position which gives most relief to the pain caused by his injury; he keeps the affected segment of the limb rigidly in this position, and at the same time he often abstains from moving the limb as a whole, as this too would cause pain. Both the reflex and semiconscious local spasm and general inhibition are liable to be perpetuated by autosuggestion when the condition of the wound improves and the pain diminishes, the initial reflex and voluntary conditions merging insensibly into hysterical spasm and paralysis. The patient does not realize that the absence of voluntary effort on his part had the object of saving him from pain, but believes that it was due to 'paralysis'—the direct result of his injury.

In some cases the injury itself places the limb in some abnormal position, and this is maintained owing to the pain, which the patient experiences when he tries to correct it, and to the reflex and voluntary spasm which oppose the efforts of the surgeon to replace it. This is particularly well seen in the hysterical contracture causing talipes equinovarus

(*Fig.* 506) after the foot has been twisted into this position by an accident, whether this results in a simple sprain, tearing of ligaments, or a fracture.

Occasionally an hysterical contracture develops as a sequel of local tetanus. In such cases the posture is that caused by the contraction of the muscles, which are supplied by the anterior cornu cells of the spinal cord in the neighbourhood of the point of entry of the afferent nerve fibres connected with the parts immediately adjoining the wound, from which the tetanus toxin is absorbed. When at the end of three or four weeks the tetanic spasm gradually disappears, the contracture may persist as an hysterical condition. Apart from the history, this origin should always be suspected when the spasm involves a group of muscles or the whole or a segment of a single muscle, which could hardly be thrown into action alone by voluntary effort. Thus, in one such case the knee was fixed in a position of extension by spasm of the sartorius ; and in two others the knee was flexed and the foot plantar-flexed by a localized spasm of a small segment of the hamstrings and the calf muscles respectively. Contractures of this sort could not be imitated voluntarily, but the patient had become accustomed to them whilst the tetanus lasted, and the habit thus learnt was perpetuated without alteration when the tetanic spasm was gradually replaced by the hysterical contracture.

FIG. 506.—Hysterical talipes equinovarus following a sprain, cured in half an hour after persisting for nine months.

In many cases the posture is that in which the surgeon fixed the limb by means of splints or bandages when it was first dressed. The patient becomes so accustomed to the immobility of the joint, that when the splint or bandage is removed, he fails to realize that there is nothing to prevent the return of the normal functional activity. He makes a feeble effort to bend the joint, finds that it gives rise to pain without any obvious movement resulting, and gives up the attempt in despair, reconciling himself to the notion that the joint has become fixed as a result of the operation, and that no voluntary effort that he can make will have any effect upon it. A little manipulation, accompanied by a few words of explanation, could at this stage dispel the idea in five minutes, and months of disability would be saved. But too often the after-treatment is neglected, or the patient is ordered massage and perhaps diathermy and kataphoresis, which are given systematically by sympathetic nurses, with the result that the patient becomes more convinced than ever that there is something seriously the matter, and that he will only get well with prolonged treatment, if indeed he will get well at all.

Hysterical contracture following an operation, cured by persuasion in five minutes.

Pte. H., age 30, had the internal semilunar cartilage of his right knee removed on Feb. 12, 1918. We were asked to see him on April 5, as he could still only walk with the aid of sticks, and was afraid to put any weight on his leg, his knee being kept quite stiff. By means of simple persuasion, which took only five minutes, he was able to walk quite normally, no limp being perceptible. He walked back to his ward, leaving his sticks behind. He had not the complete range of flexion that he had in the other leg ; but he had quite enough to enable him to walk and run and to become once more an efficient soldier.

In cases of this kind the posture may alter from time to time if the splint is changed. Thus, a man was wounded in the wrist, and his hand was bandaged with the fingers tightly clenched. Some weeks later the surgeon found that the hand had become

contracted in this position. Under an anæsthetic the fingers were now fixed on a splint in a position of extreme hyperextension. Six months later his hand was still rigidly fixed in the new position. He came under the care of Captain A. Robin, who rapidly cured him by psychotherapy. As the posture is artificially produced by the use of splints, it may sometimes be one which cannot be imitated voluntarily ; but it is none the less hysterical, the patient having been trained to maintain the position whilst the splint was in position.

In all these conditions the development of the hysterical contracture and associated paralysis is due to the fact that the patient fails to realize that there is no reason why the spasm should not relax and the power of movement return when the primary factor—nerve injury, protective reflex, conscious or subconscious antalgic spasm and inhibition of movement, localized tetanus, or fixation by splints or bandages—is no longer operative. The patient regards the contracture and inability to move as a direct result of his injury, and naturally ignores the intermediate cause, such as the pain or tetanus. If it had been pointed out to him, when the pain was disappearing, that his incapacity was due to the pain and only indirectly to the injury, and that there was therefore no longer any reason why it should be maintained, he would have made the necessary effort, and the hysterical condition would never have developed. But not having been told this, and perhaps having been ordered treatment with massage or electricity at a stage when such treatment could have been of no real use, as recovery from any organic injury which may have been present at first was now more or less complete, the idea of incapacity was confirmed in his mind, and the original autosuggestion was fortified by the unconscious heterosuggestion of the doctor and the masseuse, with the result that the contracture and paralysis were perpetuated as hysterical conditions after the primary cause had disappeared.

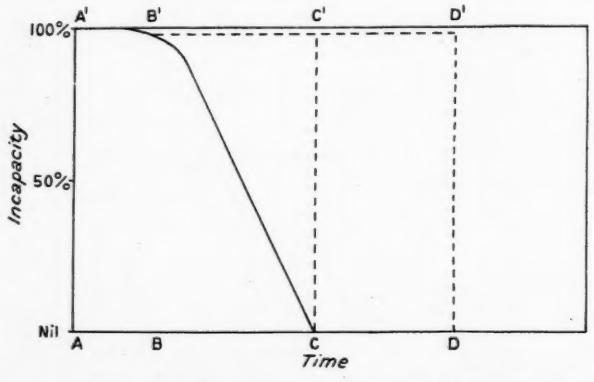


Diagram I.—Hysterical contracture following painful wound. (The dotted lines in this and other diagrams represent the hysterical incapacity.

The development of the hysterical contracture and paralysis is shown in *Diagrams I* to *III*, the vertical representing the degree of spasm and paralysis, and the horizontal the time elapsed since the onset.

In *Diagram I* the incapacity due to an antalgic protective reflex and conscious and subconscious antalgic immobility and rigidity is at first complete (AA'). It continues to be so for a certain period, and then at the time B it begins rapidly to diminish, and completely disappears when the wound is healed at the moment C. Meanwhile, however, the immobility and spasm may persist owing to auto- and heterosuggestion, and the functional condition may show no improvement at the time C', when CC' represents the incapacity, which is now entirely hysterical. At this moment, or any subsequent moment such as D, a cure can be obtained by psychotherapy, the rapid recovery being represented by the line DD'.

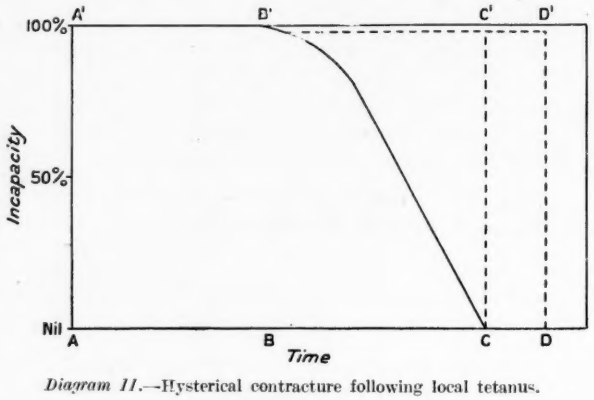


Diagram II.—Hysterical contracture following local tetanus.

In *Diagram II* the condition in localized tetanus is represented in the same way, but here the period AB is much more prolonged.

In *Diagram III* the condition which may result from the prolonged use of a splint is represented; but, in this case, the moment it is removed, all the non-hysterical immobility caused by the splint of course disappears, this being represented by the vertical line BB′, instead of by the sloping line BC′ of *Diagrams I and II*.

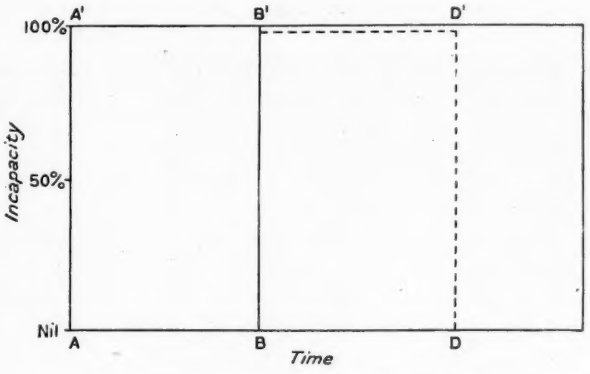


Diagram III.—Hysterical contracture following application of splint.

From what has been said above, it is clear that contractures are always associated with more or less paralysis; but the reverse is not the case, as uncomplicated hysterical flaccid paralysis is not uncommon. In many cases the paralysis is more extensive than the contracture, a contracture of the hand, for example, being sometimes accompanied by paralysis of the whole arm.

ETIOLOGY.

Hysterical contractures and paralysis may result from injuries to the soft parts of the limb, with or without the bones and joints being involved. The commonest cause is a wound of the hand, foot, forearm, or leg, the symptoms generally developing below and above the injury as well as in its immediate neighbourhood. In many cases no nerve is involved, but in others temporary concussion of one or more peripheral nerves or of the brachial plexus may have occurred, or they may have received some actual injury of a recoverable nature. The severity of the symptoms does not vary with the degree of infection or the extent of the injury, which is often trivial. They are very rarely associated with severe wounds, but we have seen a considerable number of cases in which hysterical contracture and paralysis has occurred in the hand after one finger has been amputated (*Figs.* 507, 508), and less frequently in the foot after the amputation of a toe.

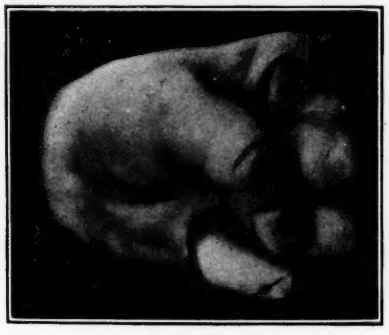


FIG. 507.—Hysterical contracture of hand persisting for nine months after amputation of second finger. (Capt. A. Robin.)

FIG. 508.—Same hand as *Fig.* 507, cured after half an hour's psychotherapy.

In other cases a severe injury to one finger has resulted in contracture affecting the whole hand (*Figs.* 509, 510). We have observed contractures and paralysis of exactly the same nature in the absence of actual wounds—as, for example, in fractures, dislocations, sprains, and contusions. In a few cases the symptoms have followed some minor opera-

tion, such as for a ganglion of the wrist, varicose veins in the leg, or an abscess of the arm or leg. In one case it followed plating a fractured tibia; three cases followed superficial burns; two followed cellulitis; and one case of flaccid paralysis of the arm followed anti-

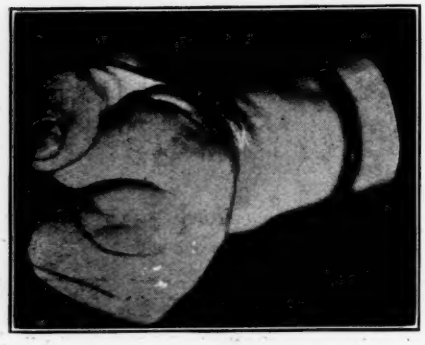


FIG. 509.—Hysterical contracture following gunshot wound of hand with shortening of middle metacarpal. (Capt. C. H. Ripman.)

FIG. 510.—Same hand as *Fig.* 509, cured in five minutes after persisting for thirteen months.

smallpox vaccination. Several cases of hysterical contracture and paralysis of one or both legs followed trench foot; and we have seen seven cases in which the hysterical contracture appeared to be the sequel of localized tetanus.

Hysterical monoplegia of seven weeks' duration following vaccination, cured in three-quarters of an hour.

Rfmn. D., age 21, was admitted on Aug. 12 with paralysis of the left arm. He states that he was vaccinated on May 30, and on June 28, when at squad drill, he found that his left arm had suddenly become powerless. The limb was hanging useless by his side, and the hand and lower four inches of the forearm were blue and cold, the palm being mottled and purple. Persuasion for a quarter of an hour produced movements of the arm; in half an hour the colour and temperature were normal; and all movements of the limb, including the fingers, were perfect after three-quarters of an hour, though the hand-grip was not perfect until the next day. (Capt. G. McGregor.)

Hysterical rigidity of knee of three months' duration following superficial cellulitis, cured in half an hour.

Pte. S., on Oct. 4, 1917, developed a large septic sore on the outer side of his right knee, which was incised a week later, a back splint being applied. The latter was removed on Nov. 7, when the knee was found to be rigidly extended. On Dec. 28 free movements were obtained under an anæsthetic, but on the patient coming round, the knee remained fixed as stiffly as before. There was no improvement under massage, and on Jan. 28, 1918, he was sent to us as an out-patient. Within half an hour, by means of explanation, manipulation, and persuasion, 30° flexion was obtained. He was instructed to perform exercises, but when seen again on Feb. 18 very little further improvement had occurred. Another half-hour of similar treatment resulted in full flexion being obtained, and the patient was discharged a few days later. (Major J. L. M. Symns.)

Hysterical 'main d'accoucheur' and anæsthesia following concussion of median nerve by gunshot wound of the forearm, cured by manipulation and persuasion in ten minutes, after persisting for eight months.

Sergt. M. was wounded in the right forearm on April 10, 1917, a compound fracture of the middle third of the radius being produced. When the splints were removed three weeks later, his hand showed a typical 'main d'accoucheur' deformity, the fingers being rigidly extended and pressed together. Total anæsthesia was present in the area supplied by the median nerve. As no improvement had occurred by November, an operation was performed, and the tendons and median nerve were freed from adhesions. This, however, aggravated the contracture, so he was transferred to us on Dec. 21, 1917.

Well-marked vasomotor disturbances, excessive sweating, and considerable atrophy of the soft tissues and nails were present. On the day of admission the hand was continuously but painlessly manipulated, the patient being persuaded at the same time that it would rapidly relax. In ten minutes complete relaxation was obtained and the deformity had disappeared. The fingers, which had not been moved voluntarily for eight months, could now move normally, but an area of total anæsthesia was still present. The anæsthesia was doubtless originally organic in origin, but as it now extended considerably beyond the area supplied by the median nerve, we thought that it must be hysterical. Suggestion with the aid of faradism, for a few minutes on two occasions, resulted in its complete disappearance. With the return of movement the vaso-

motor and secretory disturbances disappeared. A slight degree of wasting of the small muscles of the hand was now found to be present, but otherwise the hand was normal in every way. The patient was kept under observation for three weeks, and as there was now no incapacity he returned to duty.

VARIETY OF POSTURES.

In most cases a single segment of a limb is involved, the hand and foot being most frequently concerned. Very often, however, the whole or greater part of the limb is affected, but in such cases the contracture and paralysis is most severe in the immediate neighbourhood of the injury, although in rare instances the whole limb is completely paralyzed and rigid.

Upper Limb.—Hysterical contracture and paralysis of the hand give rise to three common types of posture. The fingers may be extended, in which case they are generally also adducted towards the middle finger, a 'main d'accoucheur' resulting (*Figs.* 511, 512, 513); in the case shown in *Fig.* 514, the fingers were abducted as well as extended. The other extreme is for the fingers to be tightly clenched into the palm of the hand; all the fingers may be involved (*Figs.* 503, 515), or only two or three (*Fig.* 516), in which case one finger may occupy an intermediate position (*Fig.* 517); in these cases the skin often becomes sodden with sweat, owing to the impossibility of evaporation and the difficulty in washing; in one case, in which the position had been maintained for two and a half years, the nails of three fingers were found to have produced a depression about a quarter of an inch deep into the palm of the hand (*Figs.* 518, 519). In the third variety, the hand takes up an intermediate position very similar to that assumed normally at rest.

FIG. 511.—Hysterical 'main d'accoucheur' following wound of forearm. (Capt. R. G. Gordon.)

FIG. 512.—Same hand as *Fig.* 511, cured in one and a half hours after lasting eighteen months.

In the extended and clenched positions the paralysis is always accompanied by more or less contracture; the intermediate position is that generally assumed in flaccid paralysis

(*Fig.* 520), but it may also be associated with contracture (see *Fig.* 505), though this is rarely severe. In most cases all the fingers are affected, but sometimes, especially when

FIG. 513.—Hysterical 'main d'accoucheur' following wound of the hand, cured in five minutes after persisting for ten months. (Capt. A. W. Gill.)

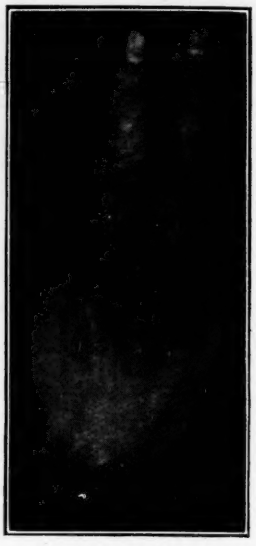


FIG. 514.—Hysterical contracture following amputation of index finger, cured in one hour after persisting for twelve months. (Capt. A. Robin.)

the condition has followed an injury of the hand or wrist, only those fingers most directly involved by the wound are implicated, the others being either normal or only comparatively slightly involved. Occasionally the fingers are in a position of extreme hyperextension, which may be so marked that it suggests that the condition cannot be hysterical in origin (*Fig.* 521). In most cases of this sort, however, it is found that a patient has always been able to hyperextend his fingers, and a similar, though rarely so well-marked, hyperextension can be produced by voluntary action in the other hand.

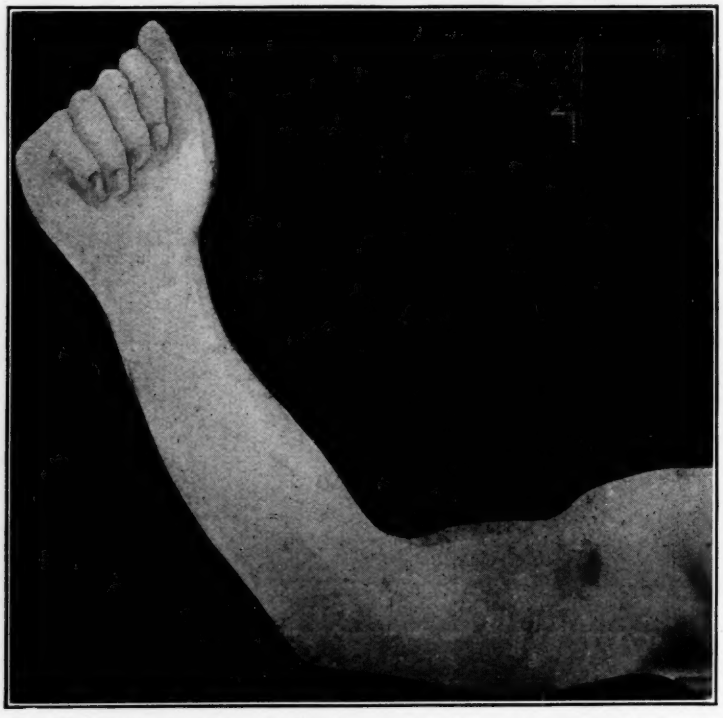


FIG. 515.—Hysterical contracture of fingers following wound of right upper arm, cured by psychotherapy in one hour after persisting for sixteen months. (Capt. A. W. Gill.)

When the wrist is involved, it is commonly in an intermediate position or flexed; in rare cases it may be fixed even to the extent found in an organic dropped wrist due to complete musculo-spiral paralysis (*Fig* 522). Hyperextension of the wrist is uncommon.

The hand is very frequently in a position midway between supination and pronation. When the contracture is incomplete, it is almost always possible to obtain greater movement in the direction of pronation than supination, inability to supinate the hand completely being very common.

FIG. 516.—Hysterical contracture of three fingers persisting for nine months after wound of wrist, cured within an hour by psychotherapy.

When the elbow is involved, it is almost invariably flexed, but I have seen two cases of extreme extension. The flexion is generally such as would correspond with the position of the arm when held in a sling.

FIG. 517.—Hysterical contractures of fingers of twenty months' duration following gunshot wound of forearm, cured in an hour by psychotherapy. (Capt. S. H. Wilkinson.)

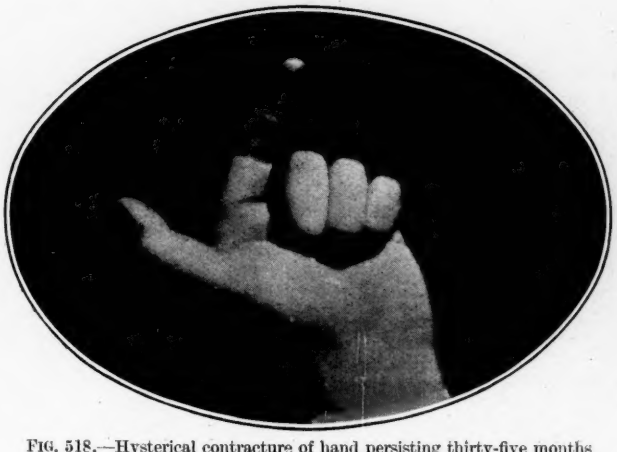


FIG. 518.—Hysterical contracture of hand persisting thirty-five months after wound near elbow. (Capt. C. H. Ripman.)

FIG. 519.—Same hand as *Fig.* 518 after half an hour's treatment, showing depressions formed in palm by pressure of nails.

When the shoulder is affected, the arm is generally held rigidly to the side. In incomplete cases, and when recovery is taking place spontaneously, it is often found that

FIG. 520.—Hysterical flaccid paralysis of left hand following wound in neighbourhood of brachial plexus, cured in an hour after persisting for eleven months. Both hands of the patient are shown, the remainder of the figure having been removed.

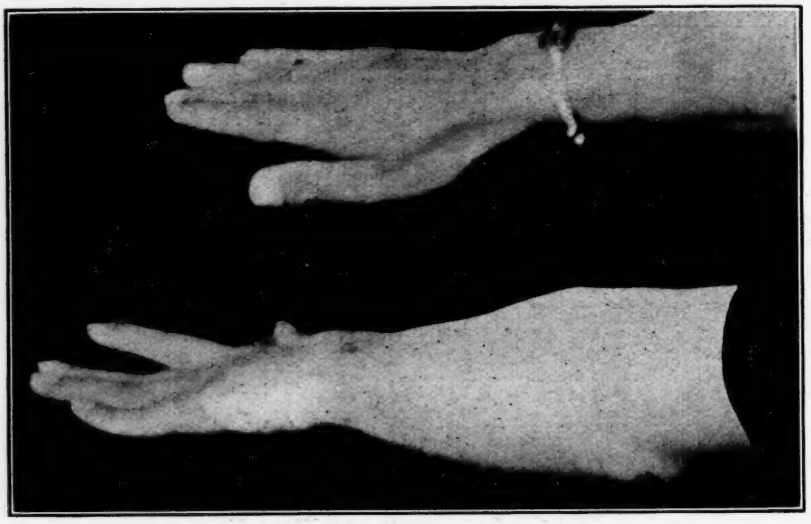


FIG. 521.—Hysterical contracture of left hand with hyperextension of fingers following a wound of forearm, cured in half an hour after persisting for seven months.

the elbow can be raised to the level of the shoulder, but it is impossible to raise it any further (*Figs.* 523, 524, 525).

Lower Limb.—In rare cases the toes alone are affected. One patient, who had been wounded in the thigh, developed a persistent flexor contracture of his toes, which disappeared as a result of psychotherapy after it had persisted for nine months.

In the commonest variety of hysterical contracture and paralysis involving the leg, the foot is extended in a position of talipes equinus. This is often associated with varus, which may be present alone (*Fig.* 526). In some cases a very extreme degree of talipes equinovarus is present (see *Fig.* 506). These conditions may be due to simple flaccid paralysis, but there is generally some degree of rigidity, and in many cases the contracture is so extreme that not the slightest movements can be obtained in the joints by ordinary means.

FIG. 522.—Hysterical dropped wrist following wound of wrist, improved in an hour, cured in three days, after persisting for twenty-four months.

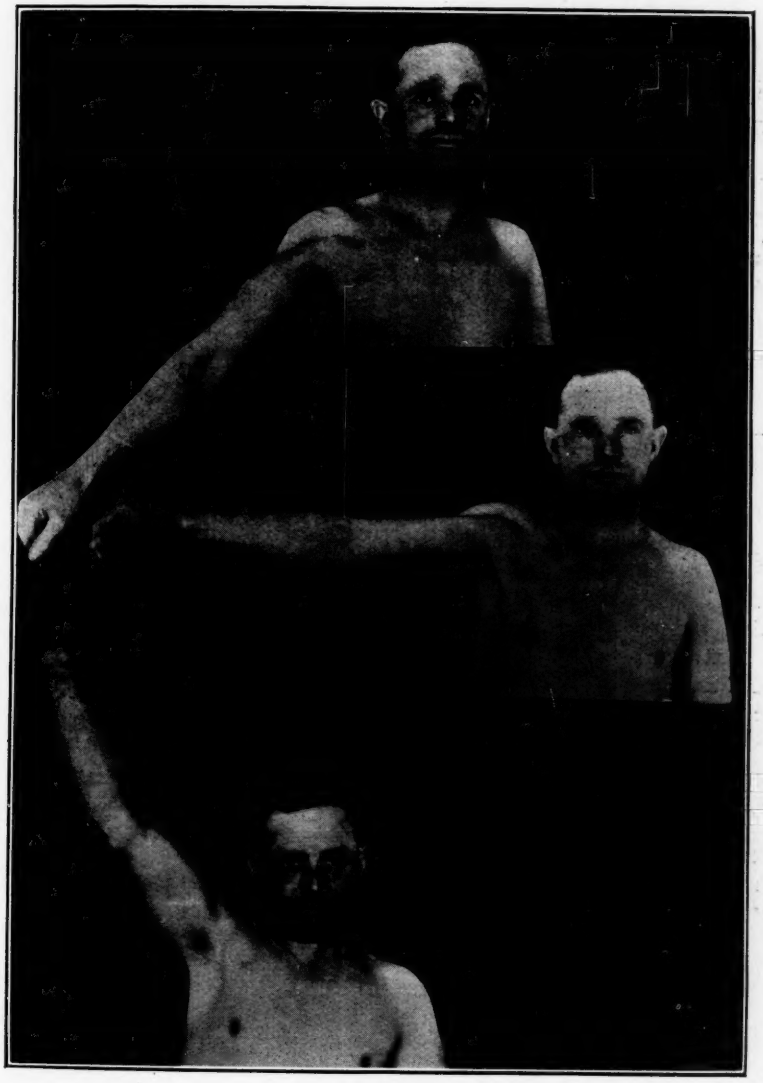


FIG. 523.—Hysterical contracture of shoulder muscles following wound in pectoral region.

FIG. 524.—Same case as *Fig.* 523 with partial recovery as the result of a quarter of an hour's treatment, after persisting for eighteen months.

FIG. 525.—Same case as *Fig.* 523, complete recovery with further psychotherapy on two following days.

Hysterical rigid talipes with paraplegia, tremor, and stammer of fourteen months' duration, cured in two days.

Sergt.-Major P., age 32, was blown up in December, 1916, and remained unconscious for some days. He was paraplegic, stammered badly, and had a generalized tremor when admitted to a provincial hospital, where he remained for three months. He was then transferred to a hospital in London, where he remained for nine months. He was treated with massage and electricity, but very little improvement occurred. A piece of bone was removed from the foot in October in order to correct this deformity, but no improvement resulted. At Christmas, 1917, he was sent to a convalescent hospital, from which he was transferred to us on Feb. 14, 1918. He stammered badly, and had a severe tremor involving both legs, which increased with every voluntary movement, so that he was unable to stand, and could only walk a few unsteady steps with the aid of sticks, when further progress was prevented by the violence of the tremor. As no signs of organic disease were found, I told him that the treatment he would have the following day would cure him, and the presence in his ward of three men who had recently been cured of paraplegia helped to convince him that this was true. By 5 p.m. the next day, as a result of persuasion and re-education, he could talk slowly without any stammer, and he walked a quarter of a mile with a gait which was normal except for a limp due to the talipes equinovarus.

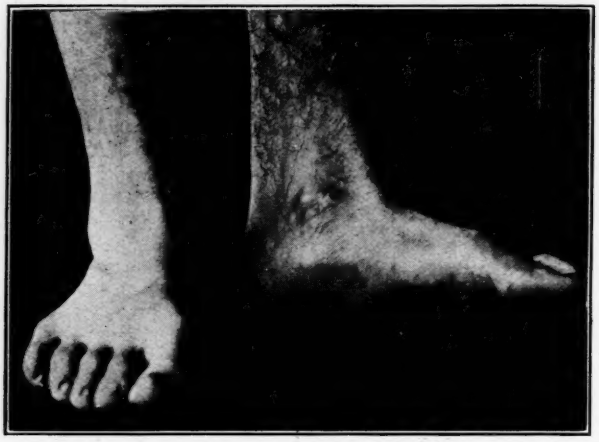


FIG. 526.—Hysterical talipes varus of thirteen months' duration following wound of ankle, cured in a few minutes. (Capt. S. H. Wilkinson.)

As I could not at first overcome the deformity of his left foot (*Fig.* 527) by manipulation, I thought it might be due to some organic injury, especially as an operation had been performed upon it after a radiographic examination in London. Moreover it was colder than the right foot, and was always wet with sweat, whilst the right foot was dry, evidence which would be accepted by Babinski as excluding hysteria and suggesting a reflex origin. More vigorous manipulation, however, two days later, continued for an hour and a half, resulted in complete disappearance of the deformity (*Fig.* 528), and the patient was now able to walk without any limp. It is obvious, therefore, that the talipes, like the paraplegia and stammer, was hysterical in origin.

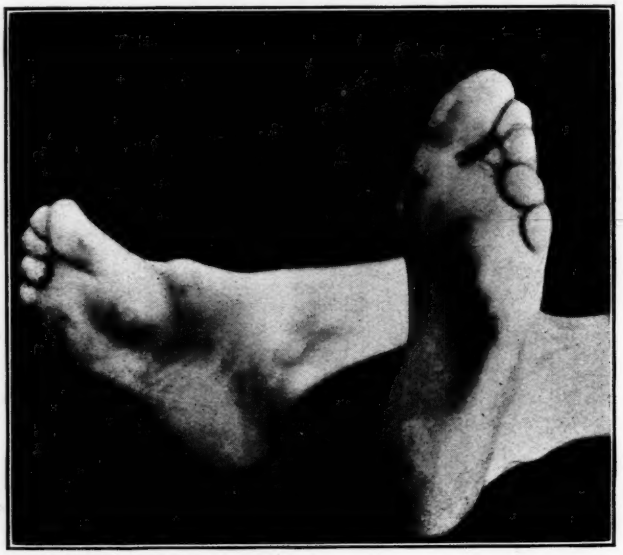


FIG. 527.—Hysterical talipes equinus of fourteen months' duration.

The knee is frequently involved, extension and flexion being about equally common. Extreme flexion is rare, but rigid fixation in a position of semiflexion is often seen. Contractures in the position of extension are frequently so extreme that not the slightest movement can be obtained actively or passively until relaxation is produced by vigorous psychotherapy.

Hysterical stiff joint following gunshot wound of the knee, cured by persuasion.

Sergt. W., age 23, sustained a gunshot wound on the outer side of his left knee on Jan. 16, 1918, which penetrated the joint. At the casualty clearing station the foreign body was removed, the joint was washed out, and the capsule closed. He reached a hospital in Scotland on Jan. 30,

and on Feb. 20 he was allowed to get up, but the limb was still in a splint, and he had to use crutches. Four months later, according to his documents, adhesions of the knee-joint were broken down under an anæsthetic, and he was sent to a Command Depôt. He was admitted to Seale Hayne Hospital on Aug. 20, walking with the aid of a stick, with a very bad limp owing to inability to bend his left knee. Except for the scar of the incision on the outer side of the joint, the knee appeared normal, but he could only flex it to about 120°. The stick was taken away, and with persuasion and re-education for half an hour complete flexion was obtained, and he walked with only a slight limp. The next day he was able to go up and downstairs and walk on the level without a limp. (Capt. G. McGregor.)

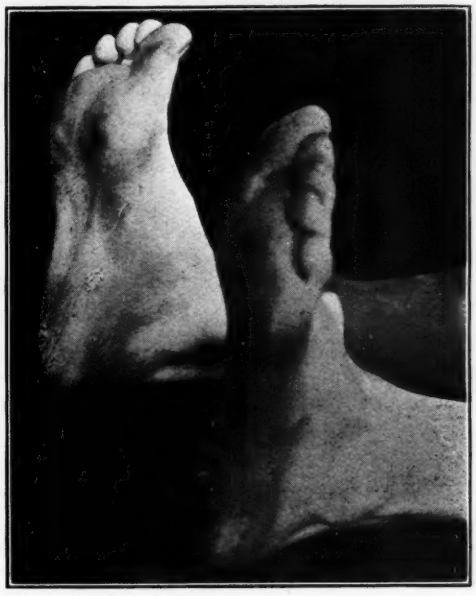


FIG. 528.—Same foot as *Fig.* 527, cured after one and a half hours' treatment.

When the hip is involved, the limb is generally in a position of slight flexion, but rigid extension is sometimes seen. Adduction or abduction, and eversion or inversion, may be present.

Hysterical flaccid foot-drop, with inversion of the leg, following a gunshot wound of the right thigh a year before; rapid recovery with persuasion.

L.-Cpl. F., age 23, was wounded by shrapnel in the outer side of the thigh on May 11, 1917. A counter-opening was made, and a piece of metal removed. He began to get about on crutches in August, 1917, but always with his foot dropped and his leg turned inwards. On his medical case-sheet a specialist reports "there was some involvement of the right sciatic nerve." He was transferred to us on May 11, 1918, with a spring attached to his boot to keep his foot up, and he could only get about with difficulty with the aid of sticks. It was explained to him that, having held his leg so long turned inwards and with his foot down, he had forgotten how to use his muscles. With simple persuasion and very little re-education he was able to walk quite well. At the end of four days he was put on horseman's work and physical drill, as he walked quite normally except for a slight tendency to allow his knee to turn inwards. With this exception he is now quite fit. (Capt. S. H. Wilkinson.)

Trunk.—A wound of the back may give rise to an hysterical spinal deformity.

Hysterical kyphosis, associated with hysterical curvature in a horizontal plane, following a wound of the back.

Pte. B. was wounded on March 21, 1918. On admission in August, he had a superficial scar, three inches long, running diagonally across his back opposite the third dorsal vertebra. He showed very marked kyphosis, which produced two deep horizontal folds across his epigastrium, below which the abdomen was round and prominent. His chest was also hollow from side to side with very marked prominence of the points of his shoulders. He breathed very badly, with no abdominal movement, and very little expansion of the lower part of his thorax. He looked so pigeon-breasted, that the deformity was considered by some observers to be organic and due to adenoids, though he himself said he was absolutely straight until he was wounded. Unlike the majority of cases of hysterical spinal curvature,* the curvature did not disappear on lying down. But, with persuasion, his body was gradually straightened out, his shoulders being pressed back until both the kyphosis and the side-to-side curvature, together with the hollowing of his chest, had disappeared. After prolonged persuasion he was able to move freely, and the depression of his epigastrium and the prominence of his abdomen with the horizontal furrows across his epigastrium disappeared. Three weeks later, being quite fit, he was sent back to duty. (Capt. C. H. Ripman.)

CHANGES SECONDARY TO DEFICIENT CIRCULATION.

The normal circulation through a limb depends upon its active movements, the afferent nerve fibres from the muscles probably giving rise to localized reflex vasodilatation. If

* A. F. HURST: The Bent Back of Soldiers, *Seale Hayne Neurological Studies*, 1919, i, 60.

for any reason the arm is not moved in cold weather, the hand becomes shrivelled, white or blue, numb, painful, and stiff. These well-recognized changes disappear at once with active exercise and on warming the limb, both of which restore the circulation. The tendency to disturbances of this kind is much greater in people with a poor circulation than in those with a naturally good circulation. The former class know by experience that they must keep their fingers constantly moving in cold weather in order to avoid getting numb.

It is thus natural for the immobility caused by paralysis or contracture of a limb, whether organic or hysterical, to result in deficient circulation and the same secondary changes. As, however, the paralysis is continuous, whereas the physiological inactivity referred to only lasts for a few minutes or at most for a few hours at a time, the secondary results are likely to become much more profound, especially in individuals with a poor circulation. The deficient circulation is generally congenital, but in soldiers it is often acquired or aggravated as a result of exposure. Thus, in all cases in which circulatory complications are severe, the circulation in the normal hand is also feeble. The limb, especially its peripheral part, becomes cold and white or blue, and the diminished blood-supply results in a diminution in the volume of the hand, except in the cases in which œdema develops. Pressure on the skin with a finger is followed by a very slow return of blood to the part rendered anæmic.

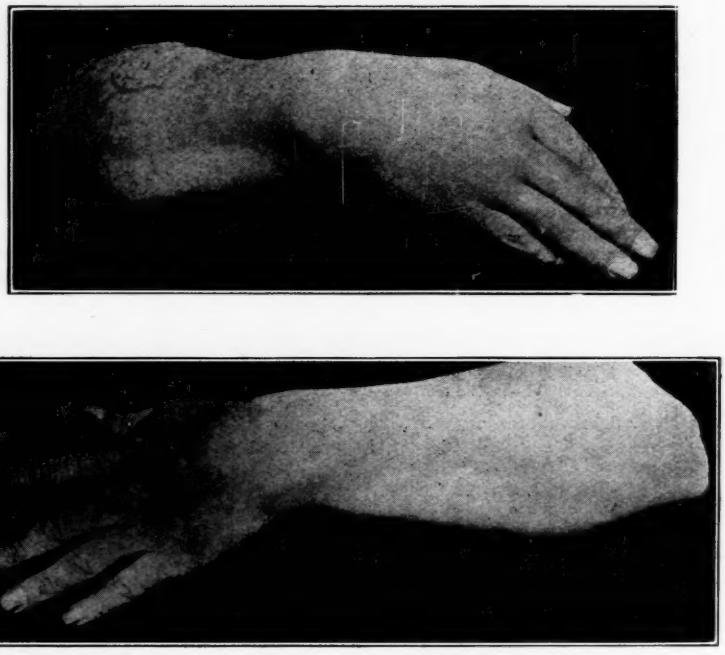


FIG. 529.—Hysterical contracture of right hand of fourteen months' duration, associated with severe œdema, cured in two hours. (Capt. A. W. Gill.)

When the venous and lymphatic stasis is very marked, and the paralysis absolutely complete, œdema may occur, especially if the paralysis is accompanied by contracture in a position in which the veins and lymphatics are obstructed by the rigid muscles. The œdema is sometimes very considerable, and may give rise to the impression that there has been some injury of the blood-vessels (*Fig.* 529). This, however, is not the case, for with the return of voluntary movement the œdema disappears in the course of a few days as the circulation becomes once again normal.

The deficient circulation results in changes in the physiological properties of the

paralyzed muscles, even if the paralysis is entirely hysterical. Babinski and Froment have shown that in these conditions the muscles respond with abnormal slowness to galvanic stimulation. They proved that this is not due to permanent changes in the muscles, by demonstrating that the response returns to normal when the limb is warmed; and we have observed that this also occurs directly recovery takes place as a result of psychotherapy, when the restoration of active movements gives rise to improvement in the circulation. Babinski and Froment also found that the muscles, and sometimes the nerves, are abnormally irritable to mechanical stimulation, the response being unusually prolonged; in some cases these signs are only obvious when muscular relaxation has been produced by a general anæsthetic. Babinski and Froment observed that when the leg is involved, the ankle-jerk may disappear or be weaker than on the normal side, returning to normal on warming. This phenomenon is clearly due to changes in the muscles, analagous to those which give rise to the abnormal reactions to electrical and mechanical stimulation. The other deep reflexes are often increased, this being most obvious when the contracture is partially overcome under light anæsthesia; the changes are probably due to the increased tonicity of the muscles, which persists until anæsthesia is very profound.

More or less stiffness of the joints is generally present in cases of long standing, even in the absence of any muscular spasm. This may be so extreme that not the slightest movement is possible. It is most obvious in the joints of the hand, particularly at the metacarpophalangeal articulations. It has often been regarded as due to some organic change, as it is very well seen in cases of organic paralysis following injuries to peripheral nerves. In such cases, so-called adhesions are often broken down under an anæsthetic, actual tearing being heard, and this is often followed by effusion round the joint. This has not unnaturally been regarded as evidence of organic change; but in all hysterical cases, and, I believe, in cases of organic paralysis, the stiffness is not really due to any permanent organic alteration in the tissues. A considerable amount of relaxation occurs when the circulation is improved by immersion in hot water, and particularly by such means as radiant heat and whirlpool baths. In hysterical cases, even of many months' duration, directly the patient has been taught to contract his muscles and to relax any spasm which is present, the return of movement so improves the circulation, that often in the course of a few minutes the condition of the joints and surrounding tissues returns to normal. As the condition of the joints is exactly similar to what is seen in organic paralysis, I feel sure that in the latter case also the condition is secondary to the deficient circulation; and if instantaneous recovery from the paralysis were possible, the joints would return to their normal condition without any manipulation or breaking down of adhesions being required. As the stiffness is due to circulatory disturbances, and not to any muscular spasm, whether hysterical in origin or not, it naturally persists under an anæsthetic; and when the joint is forcibly moved, the surrounding structures which are torn are not abnormal fibrous tissue, but simply the normal periarticular tissue, which is temporarily in an abnormal condition owing to the deficient circulation. The injury to the normal tissues naturally results in effusion. This is a point of the greatest importance, as it follows that the apparent tearing down of adhesions and production of inflammatory reaction does not necessarily mean that the condition is organic. When gas is used, or some other anæsthetic under which muscular relaxation is incomplete, any hysterical contracture which is present may also help to prevent free movement of the joint, as such a contracture, being quite independent of consciousness, only disappears under deep anæsthesia. Violent movements with incomplete anæsthesia may thus result in tearing of contracted but otherwise normal muscle fibres as well as of normal fibrous tissue.

By accurate measurement with a sphygmomanometer, Babinski and Froment found that the amplitude of the pulsation of the arteries in the affected limb is greatly diminished compared with that on the normal side. They found that this inequality disappears on warming, and Roussy and his colleagues, using exactly the same methods, noted its disappearance when the paralysis and contracture are cured by psychotherapy, proving that it is simply a result of the deficient activity of the limb.

Babinski and Froment found that the plantar reflex on the affected leg disappears,

but reappears on warming the foot. They also describe some indefinite anæsthesia in the peripheral part of the limb, and the patient may complain of a varying degree of pain. These phenomena are additional results of the deficient circulation, being of exactly the same nature as the numbness, pain, and loss of plantar reflex observed in normal people, especially those with a poor circulation, if the limb is cold or 'goes dead' in cold weather. Only if the anæsthesia is perpetuated by auto- or heterosuggestion after the return of the circulation on warming or on recovery with psychotherapy, does it become hysterical. If a nerve was damaged at the time the injury was inflicted, genuine organic anæsthesia may be present at first. This disappears with more or less rapidity, according to the severity of the injury ; but, like the anæsthesia due to the coldness, it may be perpetuated by autosuggestion, and sometimes by heterosuggestion, if too frequent examinations are made by the medical attendant. We have shown that anæsthesia of this kind may eventually be purely hysterical, and curable instantaneously by psychotherapy, although its extent corresponds exactly with the cutaneous distribution of the injured nerve, and although it had led to burns or other injuries which had not been felt (*Fig.* 530).*

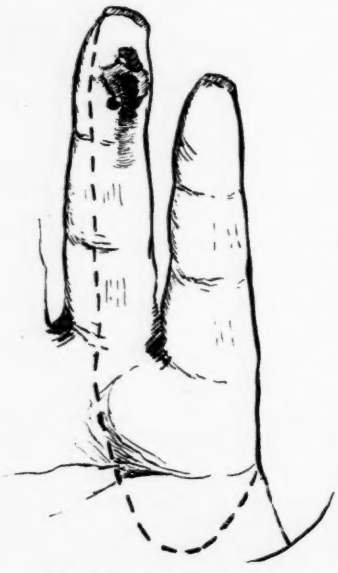


FIG. 530.—Hysterical anæsthesia in median nerve distribution, with unfelt accidental burn, cured by suggestion in less than one minute, ten months after injury to median nerve. (Capt. A. Robin.)

Hysterical anæsthesia of the median nerve, resulting in accidental burn, cured by suggestion in a minute after persisting five months.

Pte. F., age 36, received a penetrating wound of the right arm on Oct. 4, 1918, following which he had loss of muscular power of the hand, and anæsthesia of the area of skin supplied by the median nerve. The wound was excised at the casualty clearing station. He was admitted to Seale Hayne Hospital on Feb. 20, 1919, with an hysterical contracture of the fingers, the forefinger being rigidly extended, and the hand being blue and cold. He had median nerve anæsthesia, and on the outer side of the second finger was an ulcerated area about the size of a shilling (*Fig.* 530), which he stated was caused by his trying to hold a lighted match a few days previously. The contracture was

FIG. 531.—Tracing of hand (dotted) with hysterical contracture following wound of upper arm which had been present for sixteen months, superimposed on reversed tracing (continuous) of the other hand, showing atrophy of soft parts. (Capt. A. W. Gill.)

FIG. 532.—Atrophy of index finger of left hand, compared with normal finger of right hand, resulting from hysterical contracture of fingers of eighteen months' duration, drawn after recovery from the contracture.

* A. F. HURST and S. H. WILKINSON : Hysterical Anæsthesia, *Seale Hayne Neurological Studies*, I, No. 4, 1919.

cured by re-education and persuasion, and the next day the anæsthesia disappeared almost completely within a minute as a result of suggestion by means of faradism. With the restoration of the circulation and disappearance of anæsthesia the ulcer rapidly healed.

In addition to these changes, which also occur with temporary disuse, the long-continued deficient circulation in actual paralysis leads to malnutrition. Atrophy of the subcutaneous tissue occurs, with the result that the volume of the limb, particularly the tips of the fingers, greatly diminishes, and the increased blood-supply which occurs on warming the hand and on recovery from the paralysis only produces a comparatively slight increase in size, most of the loss of volume being due to actual atrophy. This is well shown in *Fig.* 531, which represents the tracing of a hand which had been hysterically paralyzed for many months, superimposed upon the reversed tracing of the corresponding normal hand ; and *Fig.* 532, which represents the first finger of a paralyzed hand compared ith that of the sound hand. The normal lines on the hands, especially the trans-

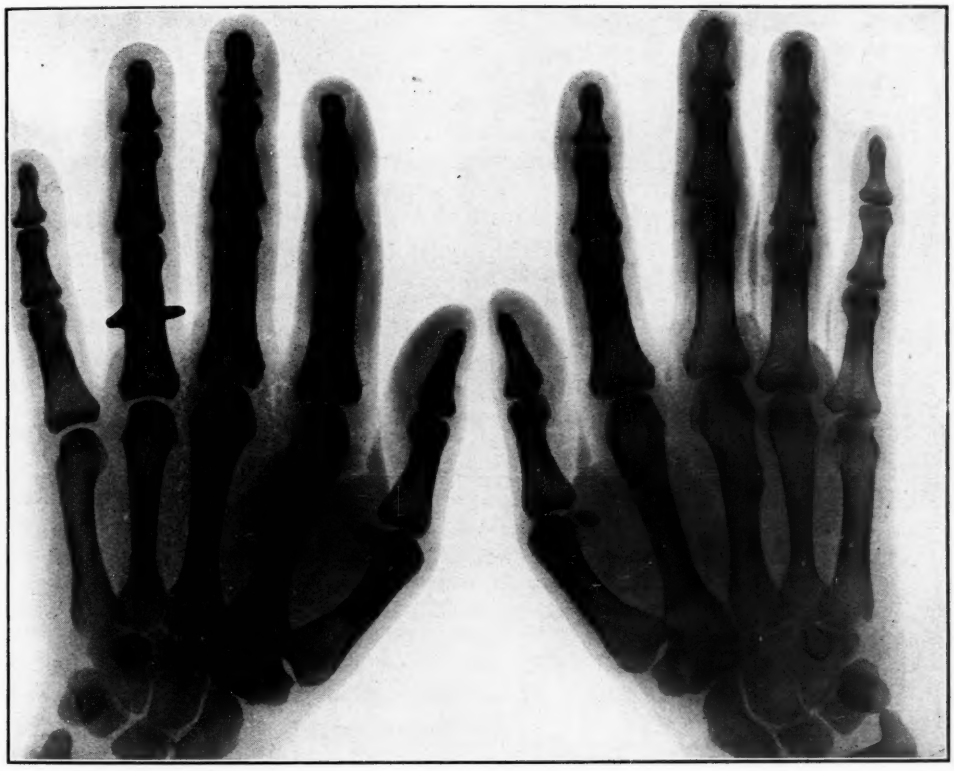


FIG. 533.—Skiagram of right and left hand, showing increased transparency of the bones of the right fourth and fifth fingers, and to a less extent the third finger, taken after recovery from a contracture involving the fourth and fifth fingers, with partial contracture of the middle finger, which had persisted for twenty months after wound of hand. The little and ring fingers also show atrophy of soft parts. (Major J. F. Venables.)

verse lines on the dorsal aspects of the joints of the fingers, become less marked and may even disappear. Owing to the diminished bulk of the fingers, the skin becomes too large for its contents and is thrown into longitudinal folds, especially over their palmar aspect. The muscles atrophy for the same reason, and also as a result of simple disuse, as their normal metabolism depends upon their activity. It is well-known that the corresponding anterior cornu cells of the spinal cord atrophy from disuse after a limb has been amputated. It is exceedingly probable that this would also occur in hysterical paralysis, as the disuse may be just as complete. If post-mortem evidence of this were forthcoming,

it would be an interesting confirmation of the far-reaching secondary organic changes which may follow disuse, even if this is purely functional as in hysteria.

The *x* rays show abnormal transparency of the bones, which is apparently due partly to deficient calcification and partly to absorption of the bony tissue, but we have never observed any definite alteration in their outline (*Fig.* 533). Although the joints occasionally appear to be enlarged, the *x* rays show no change in the articular surface; this corresponds with the fact, pointed out long ago by Paget, that hysterical disorders of joints never give rise to any anatomical change as the result of pressure exerted on abnormal surfaces, however long the condition may persist. The enlargement of the joint may be due partly to œdema from deficient circulation, but is more often simply apparent, and due to the atrophy of the soft parts round the shafts of the bones. Lastly, the nails become thin, brittle, abnormally opaque, and often show longitudinal grooves (*Fig.* 534).

Babinski and Froment rightly pointed out that the phenomena just described as accompanying functional paralyses and contractures caused by minor injuries to limbs, were not hysterical, because they were not due to suggestion, and were indeed incapable of being suggested, and because they could not be removed by direct psychotherapy. Unfortunately Babinski and Froment went further, and concluded that the paralyses and contractures which were associated with these non-hysterical phenomena were therefore also non-hysterical, but must be due to the same cause which gave rise to the latter. Although they are still uncertain as to their origin, they thought that the most likely explanation was that both the paralysis and contracture and the associated phenomena were reflex in origin, and corresponded with the atrophy and contracture in the neighbourhood of diseased joints, which Vulpian and Charcot long ago described as being due to reflex action.

FIG. 534.—Improved nutrition of nail, drawn six weeks after sudden recovery with psychotherapy from hysterical paralysis which had lasted for over a year. (Capt. A. W. Gill.)

We are, however, convinced that this explanation is incorrect, and that the paralysis and contracture are hysterical, and the associated phenomena are simply secondary to disuse. Cases of contracture in which all the signs described by Babinski and Froment were present have occurred in the absence of any wound, so that a reflex origin was excluded, their hysterical nature being subsequently proved by the cure which followed psychotherapy. Babinski and Froment had found considerable difficulty in curing paralyses and contractures of this nature by psychotherapy, which confirmed their opinion that they could not be hysterical. But our experience has been more fortunate, and we have not seen a single case in which psychotherapy failed to produce complete recovery. The accompanying table shows the results obtained in 100 consecutive cases treated at Seale Hayne Hospital, the majority, if not all, of which would have been diagnosed by Babinski and Froment as reflex nervous disorders. We have had cases precisely similar to every one of those of which photographs are reproduced in their book; the paralyses and contractures exactly fulfil the requirements necessary for a diagnosis of hysteria, being produced by suggestion and being curable by psychotherapy. The associated phenomena do not fulfil these requirements, and are therefore not hysterical; but they are none the less the direct result of the hysterical symptoms, for when the paralysis and contracture disappear with psychotherapy, they disappear with them. The return of movement is always accompanied by an improvement in the circulation, and the limb regains its normal colour and warmth. The electrical reactions and reflexes become normal at once, and the numbness and stiffness of the joints, however closely the latter may have simulated an organic condition, completely disappear. The only abnormal phenomena which are still present in the limb are the tendency to revert when at rest to the abnormal position, which I shall presently explain as a result of postural tone, and the

persistence of the trophic changes, which naturally require a considerable time to disappear completely. As soon as the limb is used as much as it was formerly—which should occur immediately the first treatment is concluded—and the circulation is consequently restored, the supply of nourishment becomes normal again, and at the same time the active contractions of the muscles stimulate their metabolism so that they, together with the soft parts, the bones, and the nails, gradually return to their original condition.

STATISTICS OF 100 CONSECUTIVE CASES OF HYSTERICAL CONTRACTURES AND PARALYSIS FOLLOWING MINOR WOUNDS AND INJURIES.

	RIGHT	LEFT	TOTAL
I. *Limb*—			
Arm ..	24	30	54
Leg ..	22	24	46

	ARM	LEG
II. *Nature of Injury*—		
Gunshot wound	23	26
,, ,, with fracture	16	1
,, ,, with amputation ..	4	—
,, ,, and tetanus	1	1
Fractures (without gunshot wound) ..	3	2
Amputations (without gunshot wound) ..	1	1
Contusions	2	10
Dislocations	1	—
Sprains	—	2
Following operation	2	—
,, vaccination, burn, cellulitis ..	1	2
Trench feet	—	1
Total (100) ..	54	46

III. *Average Period of Treatment before Admission*, 11 months.
IV. *Duration of Treatment.—a.* Number cured at one sitting, 96. Average time required, 54 minutes. *b.* Duration of treatment in other cases, 4 weeks, 8 weeks (2), and 4 days.

Fig. 534 shows very strikingly the change in the nutrition of the nail which follows recovery. The drawing was made about six weeks after the patient had been cured by psychotherapy from hysterical paralysis which had lasted for over a year. The new nail which had grown since the cure of the paralysis was in every way normal ; the distal part of the nail, which is seen in the picture to be white, rough, and thin, in sharp contrast to the pink, smooth, and thicker proximal portion, is all that was left of the nail which was present before recovery took place. Three weeks later the last trace of the abnormal nail had been replaced by healthy nail.

The striking fact that the trophic changes are most obvious in winter, when the circulation is most feeble, and in individuals who have always had a poor circulation, is only what would be expected if our explanation of the secondary nature of these phenomena is correct ; it would be inexplicable if the reflex theory were accepted.

The excessive sweating which often occurs in these cases is less easy to explain. It may in part be a direct result of the cutaneous asphyxia when the circulation is unusually feeble. In cases of contracture in which the hand is tightly flexed, it is in part due to the air in contact with the palm being kept warmer than that in contact with the palm of the normal hand, and to the diminished evaporation which occurs in the enclosed space formed by the clenched hand. We have, however, observed in several cases, when recovery is incomplete and great efforts are being made by the patient to open and close

the hand, that the actual secretion of sweat continues to be very excessive. In such cases it is possible that the intense nerve impulses sent down from the brain to the centres in the spinal cord spread from the motor nerve-cells to the neighbouring sympathetic nerve-cells which control the secretion of sweat. This would explain the fact that the sweating may occur, though to a less extent, in the normal hand.

POSTURAL LENGTH AND POSTURAL TONE.

When hysterical paralysis, with or without contracture, has persisted for some months and psychotherapy leads to rapid recovery, it is often observed that, although the patient is able to perform every movement in a perfectly normal way at the end perhaps of an hour, he tends to maintain the abnormal posture, which was caused by the paralysis and contracture, directly his attention is withdrawn from the affected limb. A man, who as the result of a wound in the upper arm has developed hysterical monoplegia with contractures, resulting in the limb being carried with the elbow flexed and the fingers rigidly extended and crowded together in the form described as 'main d'accoucheur,' may recover every movement of his elbow, wrist, and fingers in a few minutes, and at the same time every trace of rigidity may disappear, but he will probably walk away from his treatment with his elbow flexed and his fingers still bunched together. Only if he constantly thinks of keeping his limb in the normal position, does the latter gradually become adopted even when no attention is given to it.

The abnormal postures produced by hysterical contractures persist after consciousness is lost when an anæsthetic is given ; this is in part due to the phenomenon observed by Babinski and Froment, that the contractures, which they regard as reflex in origin, are maintained until an advanced stage of anæsthesia is reached. But even after the muscular spasm upon which the contracture depends has completely disappeared, the abnormal posture remains, however deep the anæsthesia may be, so that it is clear that some other factor besides the muscular spasm must be present. Babinski and Froment, in common with Scott and most other observers, assumed that this was fibro-tendinous or fibro-muscular retraction ; but the complete return to normal with re-education without any physio-therapy proves that this view must be incorrect.

Another striking fact about these conditions is the maintenance of the abnormal posture of the arm or leg during sleep. On the few occasions on which I have been able to investigate the question, I have found that hysterical contractures disappear during sleep, but in spite of this the abnormal posture is maintained, so that it is only by actually manipulating the limb that the absence of the spasm of the affected muscles can be demonstrated. The experiments of Ballet, which he believed proved that hysterical contractures persist in sleep, really only proved that the abnormal posture persists. They consisted in fixing a paper band to the affected foot in such a way that any movement would tear it ; as it was not torn during the night, he concluded that the contracture had not relaxed. It is, however, much more probable that relaxation did occur, but the abnormal posture of the foot persisted, and no movement took place when the spasm disappeared.

After the hysterical contracture and paralysis have been cured, the abnormal posture is not only maintained during consciousness, but it also persists for a time during sleep and during anæsthesia.

From the above facts it is clear that some element is present which does not depend upon consciousness, but which has the effect of maintaining the abnormal posture during sleep and anæsthesia both before and after recovery from hysterical paralysis and contracture. It is obvious that this factor has nothing to do with hysteria, as it is independent of consciousness, and is neither produced by suggestion nor cured by psychotherapy.

I believe that the explanation can be found in what Sherrington has described as postural length and postural tone. Under normal conditions the position of a limb at rest is maintained as a result of the tone of its muscles, the exact position depending upon the relative tone of the extensors and flexors. The fingers, for example, are normally

slightly flexed, and remain so not only during the waking state, but also during sleep and during anæsthesia. Each individual muscle fibre has a certain degree of tone when at rest ; and as for the greater part of every twenty-four hours it is at rest, its anatomical structure adapts itself to this tone ; but it is capable of becoming shorter as a result of active contraction, and longer as a result of active relaxation.

If, for example, the line AB in *Diagram IV* represents the length of a muscle fibre in the condition of extreme relaxation, and AC its length in extreme contraction, its normal 'postural length,' which depends upon its ' postural tone,' will be AD. It is capable of shortening from AD to AC on active contraction, or lengthening from AD to AB on active relaxation. If as the result of continued contraction of the muscle—whether this is due

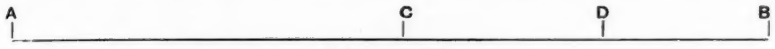


Diagram IV.

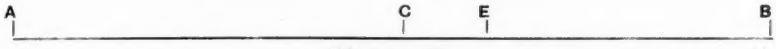


Diagram V.

to hysterical contracture, organic disease, or tetanus—its postural length, which is represented by AE in *Diagram V*, is kept constantly shorter than that due to the normal postural tone, the structure of the fibre will adapt itself to this length. Consequently, when recovery takes place, although the fibre is now capable of full contraction to the length AC and full relaxation to the length AB, yet it will tend to return when at rest, both during consciousness and during sleep and anæsthesia, to the abnormally short length AE. When as a result of an effort of will the limb is kept in a normal position for most of the day, the structure of the individual muscle fibres gradually returns to normal, and the normal postural tone is regained.

If this explanation is accepted, it is clear that in addition to the treatment of the actual paralysis and contracture in hysterical conditions, the patient must be taught to keep his limb in a natural position when he is not actually using it, and this can best be done by exercises in front of a looking-glass. Our observations show that the tone of a muscle adapts itself to new postures very rapidly, and in favourable cases a limb which has been in an abnormal position for a year or more returns to the natural one in the course of a few days.

The conception of postural length and postural tone of muscle has also considerable importance in the treatment of organic nerve injuries. A fundamental orthopædic principle is the prevention of the stretching of paralyzed muscles, the tendency until quite recently being to keep them in a condition of extreme relaxation. Experience has, however, shown that better results are obtained with a less degree of relaxation ; in cases of dropped wrist due to musculospiral paralysis, for example, the hand was formerly kept in a position of extreme hyperextension ; but recently it has been found that better results are obtained with a slighter degree of extension. The change in practice has resulted from experience, and not from theoretical considerations ; but it is easy to understand why the most recent method of treatment is the best, as paralyzed muscles, whether the paralysis is organic or hysterical, are likely to recover their normal activity most rapidly if they are kept at their normal postural length, so that when a return to voluntary power takes place, the structure of the individual fibres corresponds with the normal postural tone. The ill effects of allowing the paralyzed muscle to be overstretched is probably not due, as has been generally supposed, to any injurious action upon its contractile power, but to the development of a new postural length which results in the muscle, when it recovers its contractive power, working under the greatest possible disadvantage. At the same time the abnormally short postural length of the opposing muscle is extremely disadvantageous.

Abnormal Postural Length and Postural Tone in the Absence of Organic Disease and Hysteria.—In our study of war neuroses, we have been constantly adding to the

conditions which we believe to be hysterical, but which were formerly supposed to be organic in nature or due to some other functional condition than hysteria. I believe, however, that the conception of postural length and postural tone should result in the exclusion from hysteria of a group of cases which have hitherto been regarded as hysterical. I have already spoken about the abnormal posture which persists after the cure of hysterical paralysis and contractures as a result of psychotherapy. It is not at all uncommon for organic disease and injuries to result in abnormal postures, owing to reflex action, the prolonged use of splints, the voluntary adoption of a posture with the object of relieving pain or, in rare cases, local tetanus. When the primary condition has disappeared, the wound having healed or the disease having cleared up, there may be no contracture or paralysis left of either organic or hysterical nature, all movements being perfect and the patient being well able by voluntary action to return to the normal position. But owing to the long maintenance of the abnormal posture, a new postural length of the muscles has developed, so that at rest the limb tends to remain in the same abnormal position as it was whilst the lesion was still active. There is nothing hysterical about this, as it depends upon a structural though temporary change, and it is not produced by suggestion, although it is curable by re-education, which, however, acts in a different way to the psychotherapy required for hysterical symptoms, as it simply teaches the patient to maintain by an effort of will the natural position for a sufficient length of time to enable a new postural length of the affected muscles to develop. It is thus clear that many cases of abnormal posture, as well as some cases of abnormal gaits, are really of this nature and not hysterical. The diagnosis from hysteria can be made by the complete absence of any paralysis or contracture, and from organic disease by the rapidity with which recovery occurs with re-education.

DIAGNOSIS.

The diagnosis of an hysterical contracture depends primarily upon the incompatibility of the symptoms with the injury. On careful examination it is generally at once clear that the exact form and extent of the contracture and paralysis cannot possibly be explained by the injury inflicted upon the affected muscles, or upon the nerves which convey motor impulses to them from the central nervous system. In some cases an injury to a nerve appears to be responsible for some of the paralysis present, but it is often found that the paralysis extends to muscles supplied by other nerves which could not have been injured. Moreover, an injury to a nerve cannot account for persistent spasm of the muscles it supplies, and still less for that of other muscles; persistent muscular spasm resulting from injuries is thus invariably hysterical, unless the pyramidal tracts in the brain or spinal cord have been directly damaged. When a part of the condition is clearly hysterical, this should be cured, and an attempt made to cure the residual condition, however closely it may simulate the results of an organic lesion; for the latter is often perpetuated as hysteria, and recovery of function may take place before the disappearance of the accompanying physical signs of organic disease, such as extreme muscular atrophy, loss of reaction to faradism, and abolition of the deep reflexes. I have already pointed out that vasomotor and trophic changes, which have in the past been regarded as conclusive evidence of organic disease, may be the result of disuse from hysterical paralysis, and that it is most important to recognize how impossible it is to distinguish by simple manipulation the stiffness of joints due to organic changes in the surrounding tissue from that due to local deficient circulation, quite apart from any associated muscular spasm, the degree of which should always be carefully investigated.

According to Babinski, a further criterion for the diagnosis of the hysterical nature of the paralysis and contracture leading to an abnormal posture is the possibility of voluntarily imitating the latter with complete accuracy; for, having been produced by suggestion, and being independent of any organic condition, it should be capable of reproduction by voluntary effort. Experience has taught us that this criterion, though often a valuable aid in diagnosis, may lead one astray, as there are certain exceptions to the rule. If the posture is due to the perpetuation by suggestion of a position, which

developed under circumstances which uncontrollably placed the limb into a position the patient could not voluntarily assume, its maintenance for a more or less prolonged period before the responsible circumstances ceased to be operative would be sufficient to train the muscles involved to continue to act in the same way, and would also lead to the development of postural lengths of the muscles, which would help to keep the part in the abnormal position, even after psychotherapy had resulted in a cure of the contracture and paralysis. Thus, contractures developing after a splint or localized tetanus has kept the limb in an abnormal posture for a considerable period, and hysterical paralysis developing as the perpetuation of organic paralysis due to a nerve injury after regeneration has occurred, may be impossible to imitate. Lastly, it must be remembered that individuals vary considerably in the extent of movement they can produce at different joints. For example, a man developed a contracture of his hand with his fingers in extreme hyperextension (see *Fig.* 521), as a result of a wound of the forearm ; at first sight this was thought to indicate that the condition was organic, but it was then found that the patient was capable of producing voluntarily an equal degree of extension in his normal hand.

TREATMENT.

We have almost entirely given up hypnotism in the treatment of hysterical conditions, as our results were uncertain, and we have seen so many patients in whom prolonged treatment by hypnosis before admission had proved unavailing and had even given rise to new symptoms. Suggestion with the aid of electricity we rarely employ, except at the commencement of treatment in some cases of flaccid paralysis, in which the contractions produced in the paralyzed muscles powerfully appeal to the patient's mind.

Our method now begins with a full explanation of the cause of the symptoms in language suited to the patient's intelligence and degree of education, followed by persuasion and re-education, combined in most cases with manipulation, which doubtless acts to some extent by suggestion. A very important, but by no means essential, preliminary is the creation of a proper atmosphere of cure. Directly the patient is admitted, the sister encourages him to believe that he will be cured as soon as the doctor has time to see him, and she is often helped by the spontaneous efforts of other patients in the ward, who have been rapidly cured of similar symptoms and tell him of their cure. The medical officer sees him some hours later, and after examining him and coming to the conclusion that the condition is hysterical, he tells him as a matter of course that he will be cured the next day. By the following morning the patient is fully convinced that the hoped-for cure will take place ; as the medical officer is equally convinced that he will cure the patient, the two essentials for recovery are present. The nature of the actual treatment is really immaterial, but simple explanation, persuasion, and re-education have the great advantage of making the patient take an active part in his own cure, and remove any suspicion of charlatanism from the proceedings.

The patient is made to understand that any treatment he has already received has prepared the way, so that nothing now remains but a properly directed effort on his part, with our help, for complete recovery to take place. During the whole course of treatment he is engaged in conversation, and the meaning of each successive step is carefully explained. He is made to watch the contraction of the muscles and the play of the tendons of the normal limb, and to attempt to imitate them in the affected one.

In some cases it is not even necessary to touch the patient, mere explanation and persuasion being sufficient to cause him to relax any spasm which may be present, and then to perform the various movements of the part with quickly increasing strength and rapidity. In other cases the limb requires to be lightly supported at first, but here again no passive movements are employed. In cases of this kind the patient often expresses astonishment at the simplicity of the treatment, which succeeds in curing him in a few minutes in spite of the fact that he has previously been given massage and electricity for months without any obvious result. The explanation is that now for the first time he is made to take an active part in the treatment—to use his will power, instead of allowing

himself to become a passive agent in the hands of the masseuse. A few masseuses and electrotherapeutists realize the importance of active effort; but I have frequently seen a patient reading a newspaper which he holds with one hand, whilst his other hand is being massaged or treated with electricity exactly as if it did not belong to him. I have indeed very rarely seen a patient being encouraged throughout his massage or electrical treatment to take an active part in the proceedings. As a matter of fact neither electricity nor massage is of any use in these cases, although the average massage and electrotherapeutic department is crowded with them; for recovery should take place very rapidly, and then nothing but the ordinary activity of every-day life is required to restore any residual weakness due to the muscular atrophy caused by prolonged disuse.

In many cases of severe contracture more active manipulation is required. In our earlier cases we often forcibly moved the limb in the direction opposed to the normal action of the contracted muscles, however much the patient might complain of pain, the movements being repeated until complete relaxation and the power to perform voluntary movements were restored. Now, however, we realize that the production of pain often produces a more or less subconscious resistance to the treatment in the patient's mind. We have found that in almost every case it is possible by explanation and persuasion to get him to relax his muscles, so that passive movements can be carried out with the production of little or no pain, however powerful the spasm may be. When little or no resistance to passive movements persists, they are combined with and finally replaced by active movements until the condition of the limb is normal. In our experience it is never necessary, as recommended by Reeve, to continue the passive movements for several hours—relays of convalescent patients carrying on the treatment until finally the muscles became so fatigued and toneless that they are no longer capable of producing the original deformity. His experience is probably due to the fact that he believes his results are due to fatigue and not to suggestion; he therefore does not prepare the patient for rapid recovery, nor expect it himself, as he would do if he realized that recovery is really due to the suggestion of cure by the method he employs.

When very great difficulty is experienced in getting the contracted muscles to relax, the limb should be placed in very hot water, and the manipulations carried out when the circulation has been artificially improved in this way Some relaxation always occurs, because, as I have pointed out above, the rigidity is in part the direct result of the deficient blood-supply.

Passive movements are most effective if carried out by the medical officer himself, as the patient is engaged in conversation the whole time and made to take an active part in the movements from a very early stage in the first sitting. For this reason we never employ the mechanical appliances for performing passive movements, which have been boomed to such an extent during the last few years. Even when complete relaxation of spasm has been attained and the normal movements have been restored to a hand, the patient is very apt to forget this, and to continue to make the other hand do the work of both. After the condition has persisted for many months or even three or four years, it is only natural that this should be the case at first, if he does not think about it, as he has become so unaccustomed to having two useful hands. It is therefore of the greatest importance to give the patient some occupation, such as basket making or toy making, which will necessitate his using both hands from the very day on which recovery occurs. At Seale Hayne Hospital we have found that the men enjoyed working at a pottery we instituted better than anything else, and this has had the desired effect of rapidly training them to use the hand which is now no longer disabled. At the same time the patient is instructed to be careful to use both hands for all ordinary purposes, such as dressing and feeding himself, and in the case of the right hand he should at once begin again to write with it. A musician should be encouraged to play his instrument.

Finally, the patient should be taught to keep the limb in the proper position by an effort of will in order to restore the normal postural tone and postural length of the muscles. When the leg has been affected, it is necessary to give some re-education in walking for a few minutes in order to overcome any tendency to limp, due to the persistence of the

abnormal postural length of the muscles involved in the contracture and those which acted abnormally in order to compensate for the partial disability. Here again we have never found any apparatus, such as Zander's, necessary for the re-education of normal movements and restoration of full capacity, the ordinary activity of everyday life being quite sufficient, if the patient is made to understand that he must now use his limb exactly as if he had never been injured.

The following case is a single example out of a very large number, showing how rapidly complete recovery occurs even in very long-standing cases, in which all hope of cure had been given up.

Hysterical paralysis of the left deltoid of twenty months' duration, and hysterical contracture of the right biceps and triceps of nine months' duration, cured in a few minutes.

Pte. C., age 28, was wounded superficially over the left shoulder in August, 1916. He was in hospital for six weeks, and was then sent to his depôt. He was kept off duty, with the exception of walking exercises and attending lectures, on account of his inability to use his arm properly. He was then transferred to a Labour Company, and went to France in February, 1917. He received a slight wound of the right elbow in August, 1917. He was sent to England, and was in five different hospitals. He was transferred to Seale Hayne Hospital on May 14, 1918, with a diagnosis of " spasm of the right biceps." On examination, it was found that his right elbow was rigid and flexed at slightly more than a right angle. He was unable to abduct his left arm, the deltoid being quite flaccid. The latter condition had evidently been given up as hopeless, as no mention of the paralyzed left shoulder was made on his medical case-sheet. He had twice had his right arm forcibly straightened under an anæsthetic in other hospitals, but on each occasion the spasm had returned. With explanation, manipulation, and persuasion, the resistance of the muscles of the right arm was overcome in a few minutes. The left deltoid was stimulated with a faradic current in order to show the patient that the muscle could contract, and in ten minutes with vigorous persuasion he was able to move his left arm in any direction. He was immediately put on farm work and physical drill, and both arms soon became quite strong. He was discharged to duty on July 10, 1918. (Capt. S. H. Wilkinson.)

REFERENCES.

G. Roussy, J. Boisseau, and M. d'Oelsnitz, *Traité des Psychonéuroses de Guerre*, Paris, 1919.
J. Babinski and J. Froment, *Hystérie-Pithiatisme et Troubles Nerveux d'Ordre Réflexe*, Paris, 1917
G. Ballet, *Soc. de Neurol.*, 1915, July 29.
C. S. Sherrington, *Brain*, 1915, xxxviii, 191.

REVIEWS AND NOTICES OF BOOKS.

Equilibrium and Vertigo. By MAJOR ISAAC H. JONES, M.A., M.D., U.S. Army. Pp. 444 + xv, with 130 illustrations. 1918. Philadelphia and London: J. B. Lippincott Co. 21s. net.

THERE is a wealth of information in this book which should be of interest and value to the general practitioner, to the specialist, and to the medical officer attached to the Air Service. In fact, the book has been adopted as a standard for the Medical Division of the Aviation Section of the Signal Corps of the United States Army.

The work is divided into two parts. *Part I* deals with the practical uses of a study of the internal ear. Appreciation is made of the work of Bárány and the Vienna school of otologists in developing the tests for determining vestibular stability. After perusal of *Chapter II* the general practitioner should face cases of vertigo with renewed confidence. At the end of this chapter the author points out that although 'ear examination' does not determine everything whatsoever that has to do with vertigo, it brings order out of chaos, and makes possible accurate diagnosis and intelligent treatment.

There is a special chapter on the ear and aviation, in which the author deals with the importance to the aviator of perfectly functionating internal ears; and he describes the tests for determining the balance mechanism as adopted in May, 1917, by the U.S. Army. We think he lays too much stress on the importance of the vestibular apparatus in flying. The fact is overlooked that, for his sense of balance in flight, the aviator is mostly dependent on his eyesight. Surgeon Graeme Anderson, R.N., by ascending blindfolded in an aeroplane, found that with vision cut off one has very little sense of balance or direction. Again, the author forgets that in clouds or in the dark the aviator depends greatly on his various instruments for his stability in flight.

In the chapter on 'The Ear and Seasickness' the various theories relating to the causation of *mal de mer* are discussed, and many facts of interest are related which should prove useful to the medical officers of the Royal Navy and mercantile marine. In the remainder of the first part of the book the values of the Bárány tests are discussed in relation to the neurologist, the surgeon, the ophthalmologist, and the otologist.

Part II is given up to the anatomical and physiological consideration of the internal ear. The Bárány tests for producing nystagmus, past pointing, and falling, are given clearly in detail, and illustrated in a novel way by means of cinematograph pictures. The latter part of the book is devoted to the analysis of pathological cases.

The illustrations throughout defy criticism, and the author is to be congratulated warmly on his work. We look forward to a second edition, and would like to see expressed in it his further views on the relation of the Bárány tests to the selection of candidates for aviation. It would be of immense value to have figures comparing the findings of these tests with each aviator's flying ability at the end of his period of instruction. Our experience has been that, the less easily stimulated the vestibular apparatus, the better the flying ability; but this is a debatable point. The trained acrobat's vestibular apparatus is not easily stimulated. Major Jones's book should be read by all medical men interested in aviation.

War Surgery from Firing Line to Base. By BASIL HUGHES, D.S.O., M.A., M.B., B.C. (Cantab.), B.Sc. (Lond.), F.R.C.S., Temporary Major R.A.M.C., T.F., and H. STANLEY BANKS, M.A., M.B., Ch.B. (Glasg.), D.P.H. (Cantab.), Capt. R.A.M.C., T.F. Large 8vo. Pp. 623 + x, with 9 coloured plates and 373 figures. 1918. London: Baillière, Tindall & Cox. 30s. net.

THIS is a book of quite exceptional merit. It is the outcome of three and a half years' experience gained on both the Eastern and Western fronts, during which period the authors have had the good fortune to serve in all the different areas between the firing line and the base hospital. Their service in the busy front areas was gained in France, so that they were able to apply all the newer methods of treatment that came into vogue there between 1916 and 1917 to their work at a large base hospital at Salonika. Thus they can justly claim a familiarity with war wounds in all their phases. They have had practical experience of the early days of the campaign when sepsis was rampant, and the surgeon, groping for knowledge and overwhelmed with work, was almost powerless. They have seen the gradual perfection of methods that began to evolve order out of chaos and turned failure into success, and they have taken part in the standardization of the most successful methods and their enforcement by order.

Having had experience of wounds in all parts of the line, they have had better opportunities than many writers upon war surgery of arriving at a true judgement as to what should be done in each area, and of viewing the treatment of war injuries as a whole in its true perspective. Those whose experience has been gained in a limited area only, are too prone to judge the subject as a whole by the small sample presented to them. Thus, the front-line officer is apt to be mostly concerned with questions of hygiene, mortality, transport, accommodation, and shock; the surgeon at the casualty clearing station with the early treatment of wounds; while the surgeons at the base hospitals concentrate upon the treatment of septic wounds, secondary operations, and the like. Each is apt to look upon his sphere of observation as the really important phase of war surgery, unless experience in other areas has enabled him to bring his observations into proper focus. The book before us is free from any fault of this character. It takes as its keynote the gunshot wound of the present war and the pathological processes that occur in it. This is the peculiarity of war surgery as we know it, and to this all other complications, such as injuries to bones or joints, are secondary in importance. And therefore it follows that it is the treatment of the wound itself that is the essential point.

The theme of the war wound is admirably dealt with by the authors. No clearer or more interesting survey of the subject has been written, and the reader's feeling on finishing it must be one of regret that the ephemeral nature of the subject must of necessity relegate so able a book ere long to the limbo of the many half-forgotten things connected with the Great War. The authors' apology in the preface for shortcomings on the score of the work being written under active service conditions in the East, where there was no access to any library of reference, is entirely unnecessary. An outstanding feature of the book is the great amount of information upon ancillary subjects that it contains. It is a remarkable tribute to the general knowledge of the writers that such a book could have been produced under such circumstances.

The chief part of the work upon which the book is founded is the personal experience of the authors. Most of this was done in the Salonika area, and it is interesting to find they are as enthusiastic in favour of the Carrel-Dakin method as the most devoted disciple in France. The history of this method will prove an interesting and illuminating study to students of war surgery. Apart from being a triumphant vindication of the value of associated departmental work—in the vernacular of the moment, 'team-work'—it has enjoyed in our armies the distinction of being almost the only surgical method laid down by order and enforced according to plan. There are some who think that the main lines of treatment in the army should be prescribed and enforced by authority, instead of allowing to each individual the unfettered exercise of his own judgement. The history of this method of treatment will afford these authorities much satisfaction, and in this connection the views of the authors upon the necessity of spending time—much time—in the acquisition not only of its general principles, but the minutest details of its technique, should be carefully taken to heart by those who are ready to introduce modifications of their own before they have mastered the teaching of its distinguished originators. All through the book the authors display a profound acquaintance not only with the true aim of the method, but also of its very varied applications. Nowhere, even in Carrel and Dehelly's own book, have we seen the matter better set forth.

The account of the general nature of wounds is excellent. All the special features of war wounds—the disruption and stunning of the tissues, and the latent and distant damage—are clearly emphasized and receive their due significance.

The information with regard to the bacteria of wounds is peculiarly rich. All the micro-organisms infecting wounds are clearly classified and described, and their biology is fully gone into. Their methods of growth, and the effects they produce upon the organism in general and the tissue in particular, are given with a clearness and precision that mark the writers as no mean pathologists. The description of the anaerobes is particularly good, and there is an excellent description appended of various simple anaerobic culture methods.

The subject of wound infection is ably dealt with, as might be expected from writers who have been so often called upon to treat wounds as they are made.

The predisposing causes of wound infection are fully examined. Fatigue, climate, and want of cleanliness have all played a part in this war in the production of trench ailments, the due importance of which has only recently been recognized. The authors present us with a description of the soldier's life that deserves to be read for its literary savour as well as its professional accuracy. Shock and hæmorrhage, dangerous enough as causes of immediate death, have assigned to them their proper importance as powerful predisposing causes of infection—one of the most valuable lessons that front-line treatment has taught us. As might be expected from surgeons who have served in the East, the authors have a good deal to say with regard to the evils produced by flies. We are interested to see that they have arrived at the conclusion, shared by many in different fields of warfare, that the larval form, the maggot, may have an apparently beneficial effect in some cases of badly lacerated wounds.

The chapter on the general pathological processes underlying the phenomena of wound infection is accurate; concise; but ample for the student or the practising surgeon. The microscopic appearances of the wound secretions at various stages of treatment, based of course upon the routine at Compiègne, are all that could be desired both in the way of illustration and description. All this leads up to the description of the treatment of wounds by the Carrel-Dakin method, which for the authors is the only method deserving of any serious consideration. Upon this subject

they are perhaps better qualified to speak than many, for, owing to the military situation, they were able to treat a very large number of cases from beginning to end. This special experience therefore enables them to express opinions upon the merits of the Carrel-Dakin treatment that must be received with due respect. It is one thing to give an opinion upon a method of treatment after such an experience of it in a long series of cases, and quite another when views are founded upon experience derived from cases that have passed through many hands. The results claimed by the writers go a long way to counterbalance the obvious objections that the complicated nature of the treatment is apt to provoke in the minds of those who have not practised it assiduously and with devotion. Its exact place in surgery is still difficult to define, but there can be no doubt that under certain circumstances it is invaluable, and cannot be efficiently replaced by any other plan.

The second half of the book is devoted to the treatment of special injuries. The chapter on injuries of joints is of a high degree of merit. It is full of important anatomical and pathological information, while the part devoted to treatment is of exceptional interest. The question of immediate resection of the wound track in these injuries, and especially those of the knee, is dealt with ably, but the chief interest lies in the results obtained by the use of the Carrel-Dakin method. As the writers followed their cases from beginning to end, their report upon this difficult group of injuries ranks in value with the best accounts we have seen in the literature of the subject.

We have said enough to indicate that this book should be in the hands of all who are concerned with war surgery. It cannot fail to interest, even when the methods followed by the authors do not coincide with those of the reader. It is pleasantly written and admirably got up. The illustrations are good, though the coloured plates might have been dispensed with.

Surgery in War. By Lieut.-Colonel ALFRED J. HULL, R.A.M.C., F.R.C.S. Second edition. Pp. 624 + xv, with 210 illustrations. 1918. London: J. & A. Churchill. 25s. net.

THIS book may justly be regarded as the standard text-book on the surgery of this war. The first edition, issued early in the campaign, was for a long time the only book of its kind in the language that could be regarded as comprehensive. Because of its general accuracy and completeness it became the guide and book of reference for all who had to deal with war casualties. The increase of knowledge and the ever-widening scope of surgery in war has called for a revision of the original work, and, as might have been expected, the magnitude of this task has compelled the author to call to his assistance a number of collaborators. To each of these a subject to which he has devoted special attention is allotted. The result is a large text-book, which, while it may suffer somewhat from the point of view of homogeneity, undoubtedly gains considerably in completeness and in authority.

The book, after a preface by the Director-General, Sir T. Goodwin, opens with an excellent introduction by Colonel Pilcher, C.B., D.S.O., which calls attention to the recent changes that have been made in the treatment of the wounded, the developments in the methods of collection and forwarding of the injured men, and the improvements in surgical technique. It is interesting and instructive to find this authority writing: "It would almost seem that the chiefs of the Army Medical Service, acting by the advice of their surgical consultants, must in the future exercise a more direct control over the various methods of treatment of wounds in warfare. This might well be done without interference with individual enterprise and the issue of direct orders, or even destructive criticism of existing methods, but by education in methods scientifically chosen and described in pamphlets officially approved and issued at intervals." This is a view that many who have had experience of the conditions prevalent in the earlier stages of the war will cordially support. Lieutenant-Colonel Hull has some excellent remarks upon the same subject, in connection with the choice of method of wound treatment, which are to be commended strongly to the notice of all concerned His description of the methods of treatment of wounds is very complete and full of technical detail, and his views as to their relative value are sound and practical. There are few surgeons of experience who will fail to agree with him when he says: "Provided the surgical treatment is correctly carried out at the proper time, it is immaterial what particular treatment is adopted."

One of the best chapters in the book is that on tetanus by Dr. C. H. Browning, a good deal of which has already appeared in the columns of this journal. It is very concise, but it is admirably clear, and contains practically all that is of value in our knowledge of this baffling disease at the present time. The subject of anaerobic infection is adequately dealt with by Captain A. A. Petrie, and that of the treatment of gunshot wounds of the head is brought well up to date by the incorporation of the excellent work of Harvey Cushing. It would have added value to this section had the author been more critical as to the relative merits of the methods he describes. The section on the injuries of blood-vessels is very meagre, except in regard to the methods of transfusion of blood, which has been brought well up to date. A somewhat similar objection may be made to the chapter dealing with gunshot wounds of joints. This contains a great deal of valuable information as to methods, but there appears to be some want of critical appreciation of their value. It is true that the subject is really the most difficult one in the entire range of war surgery, but it is just on this account that the beginner asks for firm guidance from his more experienced colleague.

The best chapter in the book is undoubtedly that on wounds of the abdomen by Colonel Owen Richards, C.M.G., D.S.O., who was one of the small band of pioneer workers in this much revolutionized branch of war surgery. It is full of information, all of it clear, concise, and authoritative. It is worth while to quote his concluding paragraph on the future of abdominal surgery in war. He says: "Abdominal surgery, on the other hand, has only been called on to apply a technique already developed and generally accepted to the treatment of a new group of injuries under unusual conditions. The only question ever in dispute was whether it could and should be so applied or not, and, now that this has been decided, the only changes we may expect will be determined by the varying possibilities of bringing the wounded man and the surgeon together early and under good conditions." All who remember the views held by those in authority in the early days, and the difficulty that the advocates of operation had to obtain permission to decide by actual practical experience whether their views were right or not, may well rejoice that there were stout fighters for the belief that injuries of the abdominal contents in warfare did not call for a line of treatment totally incompatible with that suited to similar injuries in civil life.

Gunshot wounds of the chest are excellently dealt with by Captain W. Miller, who has brought the subject thoroughly up to date. The same may be said for that on shock. The author's account of the treatment of fractures is a little disappointing. It is very full of detail, but it leaves the reader in some confusion as to the best methods to follow. There are really very few methods or appliances in the treatment of fractures that are of outstanding merit, and the author's long war experience should have enabled him to discriminate accurately. He certainly does not do adequate justice to the valuable work of his distinguished colleague, Major M. Sinclair, C.M.G., to whose untiring efforts the present improved condition of the treatment of fractures is so largely due.

It may fairly be said of the book that it maintains its position as the leading text-book upon the subject in our language, and that it is an indispensable work for all who are called upon to practise the surgery of war. It is admirably got up and copiously illustrated. It is a great source of satisfaction to know that so useful, comprehensive, and widely appreciated a book has emanated from a member of the Regular Army Medical Service, who from the first day of the war has been engaged on active service overseas.

The Operative Treatment of Chronic Intestinal Stasis: By Sir Arbuthnot Lane, C.B. Fourth edition. Large 8vo. Pp. 328 + xii, fully illustrated. 1918. London: Henry Frowde and Hodder & Stoughton. 20s. net.

The fourth edition of Sir Arbuthnot Lane's work has been revised, and several new chapters, written by a number of contributors, have been added. Though there is no doubt that many facts of real importance have emerged from the author's prolonged investigations on the subject, it must be admitted that he has failed to substantiate his claim that the vast majority of all the diseases which flesh is heir to are caused by intestinal auto-intoxication.

The book opens with descriptions of five skiagrams of the fractured lower epiphysis of a humerus, of illustrations of the spines of a brewer's drayman and a coal-heaver, and of the skeletons of a coal-trimmer and a shoemaker. So much importance is attached to the last two, that a second description of the same skeletons, occupying 78 pages and illustrated by the same 16 illustrations, appears in the middle of the book. The ingenious application of these anatomical studies to the pathogenesis of intestinal adhesions loses most of its interest from the fact, proved by Professor Keith in a later chapter, that adhesions have little, if any, connection with intestinal stasis.

Appetite for food and sexual appetite are discussed together, both by the author and by Mr. Chapple, as if they were analogous physiological phenomena, a most extraordinary notion; and these 'appetites' are said to be seriously affected in intestinal stasis unless the patient is fortunate enough to have red or towy-coloured hair. The favourable effect of marriage on women with intestinal stasis is ascribed to the prostatic secretion, which counteracts the auto-intoxication, an opinion which surely requires more evidence in its support than the surprising statement that an extract from the prostate of the ram "has been administered very generally and apparently with marked benefit"—but whether by mouth or by a vaginal douche the author does not tell us.

The list of diseases which the author attributes to intestinal stasis begins with flat-foot and knock-knee, passes on through almost every pathological change in every organ of the body—such as atrophy, adenoma, cysts, and cancer of the thyroid in addition to exophthalmic goitre, as well as *all* tuberculosis, which can always be cured by colectomy (except advanced phthisis)—and concludes with cancer, which he describes as "the last chapter in the three-volume story of chronic intestinal stasis"! Whatever element of truth there may be in his work, statements of this kind are so obviously and grossly exaggerated that one cannot help doubting every other conclusion which the author reaches.

He describes the medical treatment of intestinal stasis as "tedious, dangerous, and at the best palliative." But the operative treatment must surely have infinitively greater danger, or it would be inconceivable that he should seriously state that "it would seem almost justifiable in an unmarried girl to resort to a pregnancy rather than to operative interference."

No more damning evidence against the author's conclusions with regard to the causation and effects of intestinal adhesions could be offered than the chapter contributed by Professor

Arthur Keith, "On the Large Bowel; from an Anatomist's Point of View." He shows that Lane's band, Jackson's membrane, and all the other bands which have been described, are present in at least thirty per cent of new-born children. The slighter forms described by Lane cannot be regarded as abnormal, but in pathological conditions the adhesions may be considerably exaggerated. In spite of his unique opportunities, Keith has not obtained a single specimen removed at operation which showed the usual signs of chronic obstruction, namely, marked constriction at the site of the adhesion or hypertrophy of the muscular coat above the adhesion. He concludes that "bands and adhesions are not the cause, but a mere accompaniment of the stasis, of embryological or pathological origin." He believes that the intestinal stasis is not due to mechanical obstruction, but to a disturbance in the neuro-muscular mechanism of the bowel, a view which he has described in detail in this journal (1915, vol. ii, p. 567).

Dr. Jordan contributes two chapters, illustrated by admirable skiagrams, his interpretation of which, however, shows the danger of attacking a problem from a single point of view; few of his conclusions are justified by the evidence he brings forward, and, as is well known, they are not supported by the large majority of radiologists. In common with the other contributors to the volume, there is a curious absence of acknowledgment of the work of others. In his reference to ileocæcal insufficiency, for example, although this is clearly inspired by the work of Case, no mention is made of this author. Many conflicting statements are made; thus, it is curious to read on page 303 that ileocæcal incompetence is 'nearly always' present in intestinal stasis, whereas on page 314 the terminal ileum is said to be 'quite constantly' dilated owing to the obstruction caused by spasm at this same point. According to Jordan a narrow intestinal lumen is sufficient evidence for the diagnosis of colitis, although it is obvious that the *x* rays can prove nothing more than that the colon is contracted, which may be due to spasm or simply to its being empty. It does not indicate the presence of inflammation, and indeed in colitis the colon is dilated more often than it is contracted, except in the mucomembranous variety.

In an interesting chapter Professor Adami repeats his belief that Lane is wrong in attributing the symptoms of intestinal stasis to auto-intoxication, his own researches and those of Rosenow having led him to believe that 'subinfection' or the continuous passage of bacteria from the bowel to the blood-stream is the main factor, though he now admits that in some cases toxæmia may play a part by lowering the resistance of the tissues to subinfection.

Dr. Leonard Williams has written a chapter on the "Medical Aspects of Intestinal Stasis," which might have been more appropriately entitled, "Humorous Aspects." It cannot be regarded as a serious contribution to the subject, but it is remarkable that, though it forms a part of a work on "The Operative Treatment of Intestinal Stasis," he appears to regard medical treatment as always sufficient, as no mention is made of surgery.

Dr. Nathan Mutch has written two chapters, the first a very technical one describing his researches on the bacterio-chemistry of the small intestine, and the second on chronic streptococcal infection of the bowel. One would have welcomed full clinical histories, continued after the discharge of the patients from hospital, before accepting the theory he shares with Lane that chronic nephritis, ulcerative colitis, chronic infective endocarditis, and diabetes are the results of chronic intestinal stasis. Considering how easy it is to aspirate the duodenal contents by means of Einhorn's evacuator, more evidence should have been forthcoming of the supposed relationship between diabetes and duodenal stasis and infection, which are regarded by him as secondary to intestinal stasis. As it is, the *x*-ray and bacteriological evidence he offers is worthless, particularly in view of the observations of Case, who found duodenal stasis in one and duodenal dilatation in none of a series of 72 cases of diabetes, examined with the *x* rays. In the single case of chronic nephritis described by Mutch there is no evidence of any causal connection between it and the intestinal condition, and the results of treatment are not even mentioned.

After the author's remark in his introductory chapters, that "if women were not imperfectly drained the gynæcologist would not have been evolved," one is led to expect something more convincing than Mr. Chapple's chapter on the gynæcological aspects of intestinal stasis. It contains nothing but bald statements, which are unsupported by any real evidence, and few of which would be accepted by any gynæcologists of experience.

Mr. Chapple states that there is now a series of several hundred cases, which have undergone operations for intestinal stasis, which are available for investigation. In view of this, it is unfortunate that neither Sir Arbuthnot Lane himself nor any of the contributors to his book have taken the trouble to compile an accurate record of the end-results of the whole series, which would be much more convincing than the mere statement "that the results are extraordinarily good."

The only detailed report of a consecutive series of cases appears to be that published by Lane in 1908; of 37 cases operated upon for chronic intestinal stasis, 7 died as the immediate result of the operation, 1 died six months later of intestinal obstruction, and 1 a year later from exhaustion. In many cases the ultimate result was not yet known, as 12 had only been operated on between a month and a year before the date of publication. W. S. Bainbridge (*Brit. Med. Jour.*, 1913, ii, 1129) reported that out of 50 female hospital patients upon whom Lane had performed colectomy for stasis between May, 1909, and October, 1913, 2 died from sepsis, 1 from pulmonary embolism, and 5 returned suffering from adhesions, of whom 1 died from peritonitis after a second operation. Colectomy is recommended for duodenal ulcer rather than gastro-enterostomy; any benefit which may follow the latter is ascribed to division of the circular muscle fibre, which diminishes the activity of peristalsis, and not to the making of a stoma.

The opinions offered by Sir Arbuthnot Lane in support of his views lack adequate corroboration from his own work, or from that of any of the contributors to this volume. Where we look for reasoned argument, we find wild assertion; we seek in vain for any record of mortality, or for any series of cases in which the previous history, the operative disclosures, the risk of operation, and the late conditions are set forth in a manner which allows a reader to form his own judgement. Our faith is tried to breaking point.

Transactions of the Sixth International Dental Congress. Edited by H. R. T. Brooks. Published by the Committee of Organization, 19, Hanover Square, W.

The publication of the Transactions of the Congress held in 1914, coincidently with the outbreak of war, has necessarily been delayed.

The proceedings were curtailed, papers promised and doubtless prepared were not presented. Under the circumstances it is surprising that this volume should contain so many interesting and valuable papers and reports. The latter vary much in character; they attempt an epitome of knowledge in certain subjects, but in many cases refer only to the work done in that country in which the writer resides. Thus, for instance, the report of T. Sydney Smith on pyorrhœa alveolaris, good as it is, contains among the fifty-two references not a single one to any paper published outside of the United States. This is equally true, perhaps more so, of some reports presented by English writers. Had these papers been discussed—or, probably more correctly, had the discussion been reported—this local character would have disappeared. The absence of reporters at the meeting of the sections of most Congresses is a fact to be deplored, for it has proved to be an inefficient method to rely on a speaker handing in a précis of his remarks.

The absence of a discussion is often a matter for great regret; thus, in view of the part saliva plays or may play in the causation or prevention of dental caries, it would have been of value had the report by E. E. Kirk on the chemistry and physiology of the saliva been amplified by some account of the work done in other countries than the United States. Several writers do give an international report, and their papers gain thereby. Among these are Brooke Nicholls, on the teeth of Australian and Tasmanian aboriginals; Angalo Chiavaro, on supernumerary cusps upon temporary molars; H. P. Pickerill, on the etiology of dental caries; George Villain, *sur l'unification de la terminologie et des classifications des déviations dento-maxillo-faciales*. Amongst the papers describing original work, we note with pleasure that of A. W. Wellings, on staining dental and adjacent tissues of certain rodents by means of trypan blue introduced into the animal during life, which is excellently illustrated by Lumière autochrome plates; and that of James W. McBain and W. A. Knight, on the chemical constitution and the physico-chemical properties of dental amalgams, which contains the results of much work done in this subject by themselves and others in the Bristol University, and considerably modifies opinions previously accepted.

Two papers, one by Truman W. Brophy, the other by H. Blakeway, on the operative treatment of cleft palate are of interest. The former believes that defective phonation has been due in many cases to lateral incisions in the soft palate, which in his opinion should never be done.

We may congratulate the editor on the way he has done his work, and the publishers on the way the volume is produced.

Nerves of the Human Body, with Diagrams. By C. R. Whitaker, F.R.C.S. Second edition, revised and enlarged. Edinburgh: E. & S. Livingstone. 3s. 6d. net.

As the title indicates, this small work is only concerned with the anatomy of the nerves, and not with its surgical application. This war and its small missiles have made many surgeons revive their knowledge of the anatomy of the nerves of the human body, and this probably has stimulated the demand for a small book thereon, well written, and by an authority on the subject. Naturally, the smallness of the price of the book has forbidden its more elaborate illustration. The figures are well done, as would be expected in a book in its second edition. Almost the only criticism called for is in regard to the index. This is but a small point, and hardly detracts from the value of the work; but only one saphenous nerve appears indexed.

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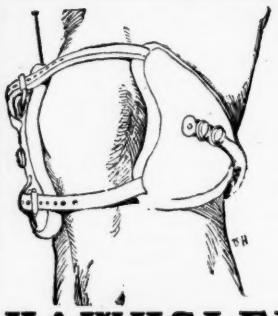

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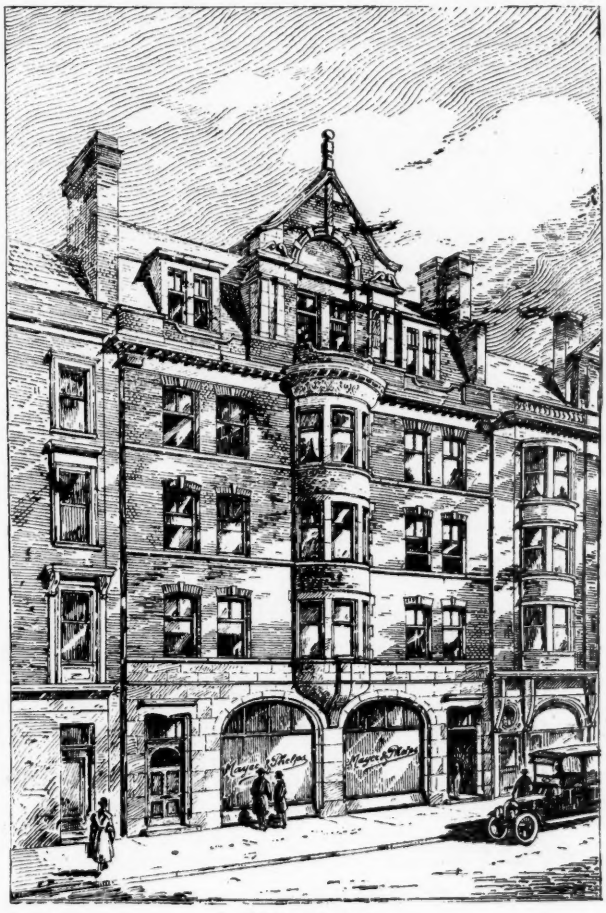

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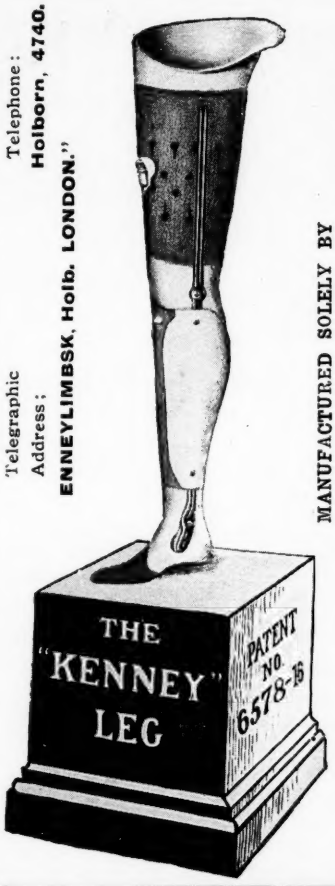

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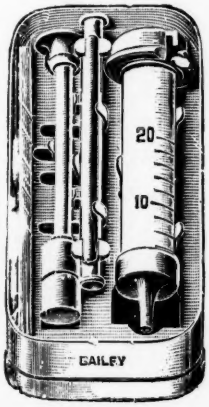

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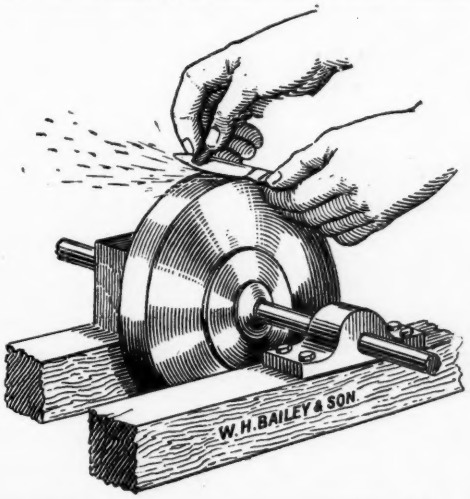

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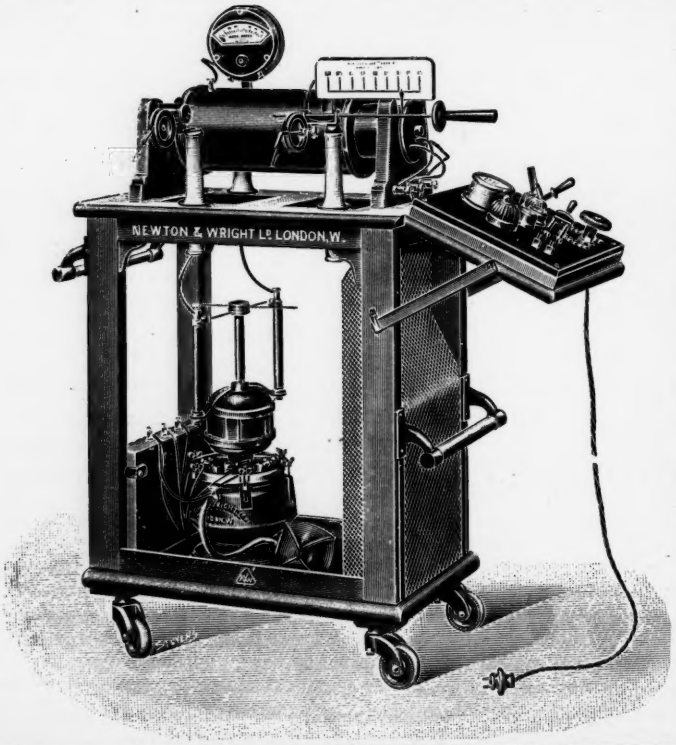

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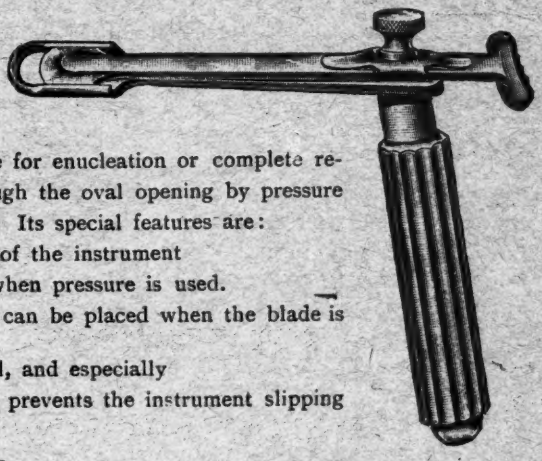

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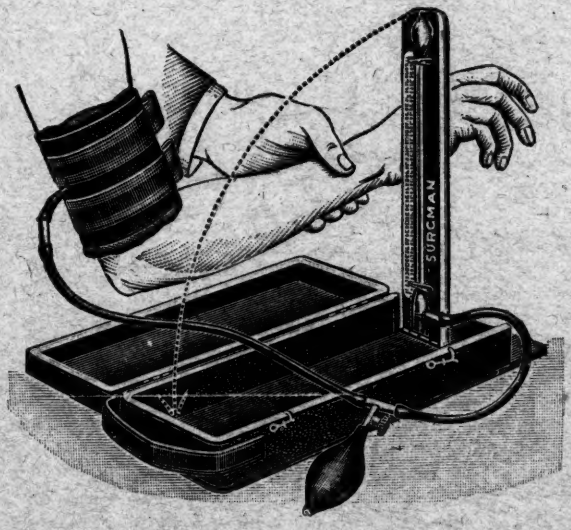

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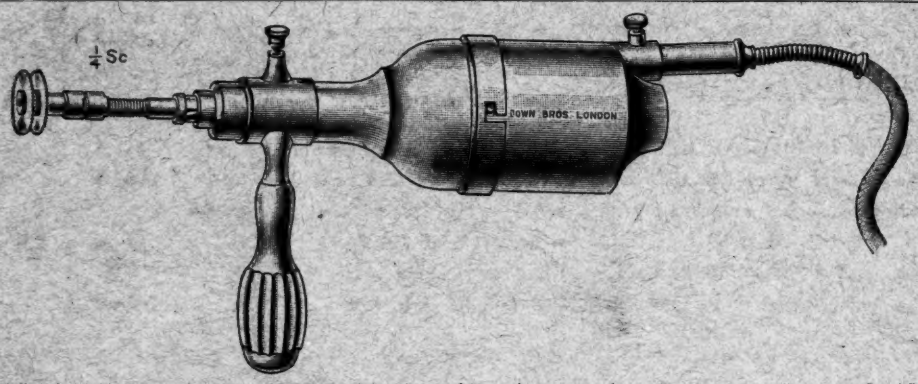

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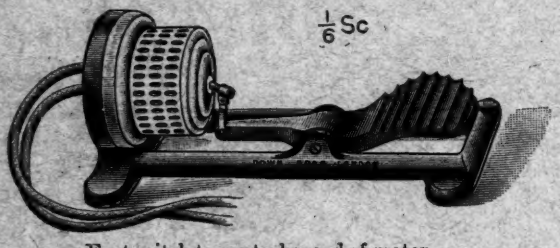

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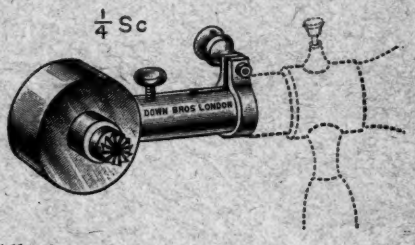

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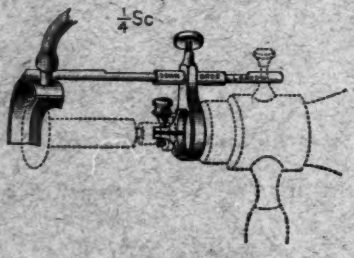

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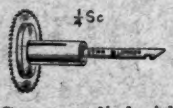

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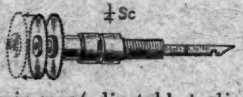

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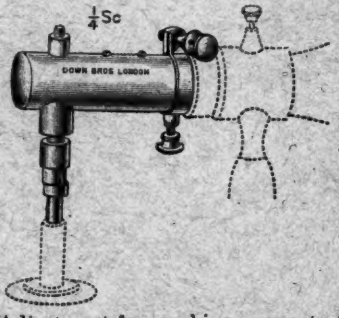

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